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In a Nutshell

It is many months since we first inspected the shell-moulding process at the Chiswick (London) Works of Polygram Casting Company, Limited. The changes which have come about since that time are outstanding in technical achievement. What was then but an interesting laboratory project has developed into a full-scale pilot plant. Moreover, the technique has been revolutionized. No longer are the castings being made in the vertical plane involving the support of a packing of steel balls in boxes. The latter system, according to reports from Denmark, demands the use of a jar-ramming device to ensure dimensional accuracy or perfection of surface. This has been replaced at Polygram by invariably casting horizontally, using four dowels to ensure proper alignment and bent nails for wedging the two half-shell moulds together.

The aspect of the foundry is quite different from the orthodox shop. The investment material—sand and a specially prepared phenolic resin—is hand mixed, and it would seem that even a quite large output of castings would only demand the type of oil-sand mixer used in the ordinary coreshop. The shell moulds are being successfully produced by a mechanized system of unique design, but as it is only in the early stages of production, a detailed description can best be left until output figures and other data have been authoritatively determined. At the moment we can but express the opinion that it shows distinct promise. The shell moulds are then transferred to a bench where, if necessary, they are cored up, using shell cores, and the two halves are wedged together by girls, using a few suitably-bent nails. Placed on a pair of rails, they are ready for casting-up in iron, steel or any non-ferrous alloy. Because of its thermal properties, cast-iron patternplates are to be preferred, but other materials can be used. Knocking out is the essence of simplicity and the resulting castings need neither shot-blasting nor fettling but only trimming, using this term to indicate runner and riser removal. The dimensional accuracy achieved is more akin to the investment process than to the standard sand-moulding practice.

At the knock-out, during the time of our visit, there were two or three barrow-loads of broken shells, and this is, we were assured, quite useless for reclamation or any other purpose. Yet in the aggregate, there is no more discard to be removed from this foundry than is the case in a sand foundry, as it is only about one twentieth of the quantity normally used. Another outstanding feature is the absence of box-parts, and instead of the long lines of moulds waiting to be poured, there are reared up in convenient positions shell moulds of such a volume that they could easily be stowed away in the baggage of the American tourist. Yet, converted into normal practice, they would fill the floor of a sizeable foundry.

(*Continued on page* 618.)

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Institute's New President

Dr. C. J. Dadswell

Dr. C. J. Dadswell, B.SC.(ENG.), *Ingénieur E.S.F.*, M.I.MECH.E., who was elected this week as president of the Institute of British Foundrymen for the year 1952-53, has been a prominent figure in Sheffield industrial circles for some years.

Dr. Dadswell is a director of English Steel Corporation, Limited, Sheffield. He was educated at Shoreham Grammar School, Brighton Technical College, and University College, University of London. His first general steelworks experience in Sheffield was with Cammell, Laird & Company, Limited, whom he joined in 1928. In 1933, whilst in the steel foundry of that Company, which by then had become part of English Steel Corporation, Limited, he won the Robert Blair Travelling Scholarship and went abroad to study for twelve months at the Foundry High School, Paris, and in Continental foundries. On his return to England, he worked as a moulder in the foundries of Vickers-Armstrongs, Limited, at Barrow-in-Furness. Shortly after rejoining English Steel Corporation, Limited, in 1934, he became steelfoundry manager at the Grimesthorpe Works. As a result of his studies abroad and on presentation of his final thesis in Paris in 1935, he became the first British subject to be awarded the diploma of *Ingénieur de l'Ecole Supérieure de Fonderie* (Paris).

During the time he was manager of the steel foundry, one of the first acid-electric steel melting furnaces was introduced to this country, the use there of synthetic sands for mechanized production of steel castings was much extended and larger steel castings were produced by green sand more regularly than ever before in this country. Other innovations were made—the production of very heavy steel castings.

In 1941 he was seconded to the Iron and Steel Control of the Ministry of Supply in connection with the building of mass-production foundries for track-link castings, in some of which, for the first time in the world, electric furnaces were used for the holding and pouring of 14 per cent. manganese-steel. He travelled to America and Canada in 1942 as the chairman of the British Armour Mission to study in particular cast armour. In 1943, Dr. Dadswell returned to English Steel Corporation, Limited, to take charge of the Drop Forge department. He later became a special director of the Company and in 1946 was elected to the Board. His other duties now include responsibility for the production and sales of drop forgings, steel castings and springs.

Dr. Dadswell has many friends in America, in Europe and other countries as a result of his travels on behalf of his Company. He has always been particularly interested in improved organization of management and the development of more advanced production methods. Dr. Dadswell is a past-president of the Sheffield and District branch of the Institute (1943-44) and has served on the technical committees of the Institute, in addition to presenting several papers to branches and conferences. He is a member of the Executive of the British Steel Founders' Association and chairman of the Lancashire and Yorkshire region of that Association. He is also chairman of the Backup Roll Makers' Association and vice-chairman of the B.S.F.A. Research and Development Division. In addition he is a member of the Institution of Mechanical Engineers and of the Iron and Steel Institute and is a Fellow of the Royal Society of Arts.

Dr. Dadswell, who spends much of his very limited leisure in the pursuit of dinghy sailing and racing, in which he is keenly interested, brings to the presidential office the valuable qualities which have made him an important industrial leader at a comparatively early age. He is especially distinguished by a wide, progressive outlook and a lively, original mind. His experiences in many branches of foundrywork, both at home and abroad, from that of practising moulder to senior executive, render him well able to view the industry with balanced perspective.

I.B.F. Presidential Address

A Sense of Proportion

By Dr. C. J. Dadswell, B.Sc. (Eng.), Ingénieur E.S.F., M.I.Mech.E.

At the annual general meeting of the Institute of British Foundrymen at Buxton on Wednesday of this week Dr. C. J. Dadswell, on being inducted into the presidency of the Institute, delivered his Address in the course of which he said:—

I have been a member of the Institute for more than half my life and practically the whole of my industrial life, but when I joined the Institute, little did I dream that I would ever achieve the great honour of becoming its president, or even a branch president, and I can remember my pride when I was elected to the latter office by the Sheffield and District branch.

We are all increasingly subject to advice and instruction by the written and spoken word, and in particular we are told how to do our jobs and conduct our businesses. Much that is said, however, is repetition; in itself perhaps not a bad thing, because we are mostly conservative by nature and it takes time for old habits to change and new ideas to develop. There are many subjects of industrial interest which have received considerable attention in recent years, but I had hoped on this occasion to avoid repetition. One sometimes disagrees with the widely-held opinions of others, and it is hoped to put in proper perspective certain things which seem not yet to be thoroughly understood or being approached with an open mind. In choosing these topics and in attempting to put them in their proper perspective, perhaps I can start other lines of thought and someone else will put down their ideas more adequately.

A Question of Skill

A question raised at the Institute's fourth Foremen's Training Course seemed to require an answer which, it was not possible to provide in the time available. A foundry was described in which a somewhat difficult casting had been made in quantities not reaching three figures per day by skilled moulders, with considerable physical effort on their part. Eventually by some modification to the moulding technique, and more particularly to the organization of work, and by the addition of some mechanical equipment of a relatively inexpensive nature, the output with fewer men and less-skilled men in the team increased to ten times as much per day. One of the questioners was worried about the effect of mechanization on the operators and held that it had deprived the skilled moulder of skilled work, even although he was assured that the displaced moulders were transferred to alternative work where their skill was still required.

There are several lessons to learn from the analysis of this question and the answer. It is wrong to assume that mechanical aids to production, simple or comprehensive, necessarily make those who operate them unhappy when they are not able to exercise their original craftsmanship. Whilst it is not often that we in the foundry go to the extreme of the motor-car assembly line, Henry Ford and other authorities have shown that the worker engaged on mass-production is not inevitably unhappy. One need not go deeply into the economics and the phychology of this situation. By observation, and I have some experience in this matter and know it to be right, with the proviso, as is always the case, that one cannot generalise and the conditions must be such that the operators are able to work steadily and with a physical exertion which is not injurious to health.

In mentioning mechanical aids to production, it should be made clear that I do not necessarily refer to handling methods by machinery of a most elaborate nature. Plants described as "fully mechanized" are in few cases completely mechanized as it is all a question of degree. After all, mechanization has existed throughout the ages in the form of simple mechanisms, as for example the rope-operated pulleyblock. In fact, a lot of modern mechanization is none other than the application of the simple mechanisms which are fundamentals of applied mechanics, but they are applied in varying degrees and nowadays with motive power rather than human power added to the mechanizm. Ultimately, one can reach the extreme stage when the only human agency is that of pressing of the button.

Science hand in hand with Labour

Talking in this strain, implying that castings can be made largely with unskilled personnel, reactions may be that I am almost sacrilegious and am contradicting both the sentiments expressed by previous holders of this office on the subject of craftsmanship and the efforts of the Institute in its encouragement of the craftsman. It may be thought that what I say is incompatible with the Institute's motto "Science hand in hand with Labour."

However, what I am trying to express is in my opinion completely in keeping with this marriage of science and labour. As foundrymen, the primary objective is to make good castings, castings which will hold their place with the products of competitive industries and will enable the users of castings to make their final products economically attractive to their own customers. If, therefore, to meet these demands it is necessary to use labour which is not trained to do a hundred and one skilled jobs, but to become specialized in doing a few, it must not be assumed that the specialized operator is unhappy. It has been proved in other trades that he is otherwise and that his economic standard can rise

A Sense of Proportion

because he participates through his increased productivity (the word has appeared at last) in a greater contribution to the total quantity of goods available for the use of mankind.

It might be thought that this would appear to be just another form of talk on economics rather than on foundrywork. I embarked on it, however, in order to stress to those, who have not yet thought it, that mechanization, simple or elaborate, should not make unhappy those who operate such plant, but should be to their ultimate advantage in health, working conditions and general standard of living.

At the Foremen's Conference the questioner said, "What of the two displaced skilled moulders?" The answer was that they were found other skilled jobs to do. I believe that, in spite of mechanical aids to production and removing the need of skill in the operators of the mechanical devices which give quantity production or even which help the work of the skilled operators (and this requires much attention), there will continue to be a need for skilled craftsmen, and thus it is claimed that all previously said is not incompatible with the policy of the Institute to encourage the training of craftsmen. At the Foremen's Conference, I pointed out that there were as yet no alternative ways of making moulds and cores for some of the castings illustrated by one of the lecturers, other than by the use of craftsmen. There will remain a need for craftsmen for work of accuracy and in small quantity which is dependent on the skills of the individual.

Work Break-down

In the present Address, I will not develop the possibility in which I believe of "breaking down" operations, even in jobbing work, and the upgrading of operators from one skill to another as is now practised in America, rather than having only one form of recruitment by youth apprenticeship into all branches of a craft—which is so often the sole qualification for what we call "skilled tradesmen." Founders are not yet sufficiently enlightened to accept alternative means of upgrading and of advancing in stages from one skill to another skill during the lifetime of a worker; although the seeds have been sown and it is already a matter of discussion. With increasing time spent on general education for all people, however, so there is less time to train a citizen to become an all-round craftsman in a wide number of skills by the time he reaches the age to take his full place as part of the productive world; we may by force of our modern desire to educate more thoroughly, eventually permit the worker to develop from stage to stage in specialization within crafts after the age at which we now expect him to have become fully qualified.

In breaking down operations to the semi-skilled, thus are created other skilled jobs, perhaps less in number but nevertheless equally skilled in their particular line than those of the skilled personnel who were replaced by the semi-skilled. More work is created for the larger numbers who receive a more comprehensive education which is now available to all—designers, engineers and technicians and, of course, other skilled artisans. All are needed to do the thinking for the development and the execution of the technical work on which production must be based.

Jobbing Founders

The jobbing foundry was referred to and, here again, there appears to be a misconception. I suggest that this is the foundry where there still is scope for improvement as compared with other branches of our industry. Mechanization, elaborate or simple, is not difficult to apply, given the type of product to which it is suited and imagination and economic conditions to justify it. It is much more difficult to improve the economic conditions for the owner and worker in the jobbing foundry unless it is tackled in just as analytical a way as when embarking on series production. There are many so-called jobbing founders who have enlightened ideas, but I feel that there are still many who could change their outlook with advantage and I do not consider it difficult for them to achieve improvement if they can understand the proper approach.

We have done a lot of talking about, comparing notes, writing lectures, and showing lantern slides of mechanized foundries. We have not done nearly so much to help the management and technicians in the jobbing foundries. This has been repeatedly impressed on my mind at the Foremen's Courses and this year the organizers tried to break away from the stress on mechanization by having some examples of controlled quality in jobbing foundries. The author of a paper presented at last year's Annual Conference—a paper which was such a good example of organized thinking and analysis of statistics in effecting improved castings made under jobbing conditions—responded to an invitation to present a similar lecture at the last Foremen's Conference; it is hoped that its lesson was understood.

The method of approach was nothing more than the keeping of records, doing simple investigations, making deductions from records, and using no elaborate statistical analysis other than logic based on causes and effects. Anyone can undertake this, whether having an elaborate laboratory or a simple organization. In listening to the paper on two occasions, one fear was that its reference to the laboratory might make people think that such control and development could only take place if a foundry had a laboratory full of technicians. The mental processes involved and the scientific knowledge required, however, were those which a foundryman, who has studied as he should have studied, would be able to undertake, the principal factor of all being analytical thought.

In the small foundry, perhaps captive to an engineering organization, it may be thought that no staff is required other than the foreman who runs the foundry floor. It is suggested that he is given the help of a man who has time to develop ideas for tooling (however improvised they may be), sufficient money and authority should be granted for them to have proper tackle, to melt up moulding boxes which should have been scrapped years ago,

(*Concluded on page* 618.)

Elected Senior Vice-President

Mr. E. Longden

Mr. E. Longden, M.I.MECH.E., senior vice-president of the Institute of British Foundrymen for the year 1952-53, received a practical training in the foundries of the British Westinghouse Company, now Metropolitan-Vickers Electrical Company, Limited, Manchester. He acquired a technical education in metallurgy and related subjects at the Manchester College of Technology, followed by studies in economics, engineering subjects and works management. He has occupied positions of foundry and patternshop manager with Tangyes, Limited, Birmingham, John Hetherington & Sons, Limited, Manchester, and Craven Bros., Limited, Stockport. Latterly, he held the position of works manager with David Brown-Jackson & Company, Limited, Salford. He resigned from this post to practise as a consulting foundry engineer.

Mr. E. Longden.

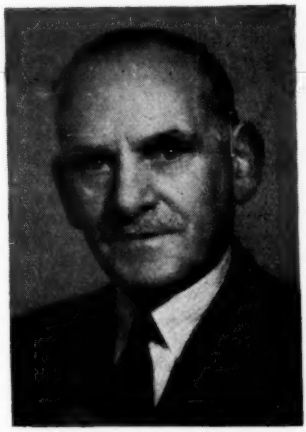
Mr. Longden has carried out much research work on a practical foundry scale. He has contributed extensively to foundry technical literature and has presented many papers to the Institute's branches and annual conferences. Following upon diploma awards, Mr. Longden was, in 1926, awarded the Oliver Stubbs Gold Medal and, in 1944, the British Foundry Medal and Cash Award. He was the Lancashire branch president in 1928-9-30 and has served on the General Council and its Committees since 1926. In 1937, he prepared the Institute's official exchange paper to the *Association Technique de Fonderie* (France) and, in 1948, the Institute's official exchange paper to the American Foundrymen's Congress at Philadelphia. Mr. Longden has travelled extensively in the U.S.A. and European countries and gained a wealth of experience which he is always ready and willing to impart to the younger generation.

Cocktail Party.—Roylee editorial services gave a cocktail party last Friday at the Savoy Hotel, London, to enable guests to meet Mr. Ernest Allison—the Author of "Fruitful Heritage." Amongst those present were Mr. C. E. Lloyd; Mr. F. N. Lloyd; Mr. Michael Lloyd and Mr. Christopher Lloyd.

Junior Vice-President

Mr. John Bell

Mr. John Bell, who has been elected junior vice-president for the year 1952-53, began his working life as a patternmaker, having served his apprenticeship with Sir William Arrol & Company, Glasgow. His early technical training was obtained at evening classes organized by the Glasgow School Board and, later, at the Royal Technical College. He left the patternshop to take up a position as draughtsman with Robert McLaren & Company, Glasgow, and in this position was responsible for the design and installation of the plant required in a foundry having a daily melt of 200 tons. Later he became works manager of the same Company. During the 1914-18 war he laid down a new melting, stamping and extrusion plant capable of handling 300 tons of brass per week and in the same plant carried through some work on the extrusion of small (¼-in. bore) tubes in aluminium alloy. After the war, he visited foundries in the United States and Canada.



Mr. John Bell.

In 1920 Mr. Bell acquired the business of Albert Smith and Company, of which firm he was, for many years, sole partner. In 1950, he was joined in partnership by Mr. Alexander Marshall, a past-president of the Scottish branch. Mr. Bell joined the Institute (then the British Foundrymen's Association) in 1917, and was appointed honorary secretary of the Scottish branch in April, 1923. His predecessor continued in office until December of that year, since which date Mr. Bell has continuously held office. Since his appointment he has attended every meeting—council, branch, social function and works visit—held by the Scottish branch and, of course, he has been an *ex-officio* member of the General Council over the same period. He is also a member of the American Foundrymen's Society.

Latest Foundry Statistics.—According to the British Bureau of Non-ferrous Metals Statistics, the output of copper-base castings during April was 6,364 tons. In the first four months of this year, it was 24,117 tons as against 21,157 during the same period last year.

In a Nutshell

(*Continued from page* 613.)

For equal production—coreshops would be the same as now—the floor space required for the rest of the processes would be about a fifth or even less. It is obvious from a visit to the Polygram foundries, that techniques have been developed and perfected, together with much "know how," as the Americans so aptly designate practically-acquired useful knowledge and "tricks of the trade." For the present there are limits as to the size of castings which can be made by this process, but no doubt time will extend the boundaries. Shell moulding is unquestionably an outstanding development and it is destined to secure for itself an important position in the foundry world of the future, but, we think, by no means to the total exclusion of the traditional methods. A pointer to the progress so far achieved is the fact that a number of substantial foundry concerns have acquired licences from the Company.

A Sense of Proportion

(*Continued from page* 616.)

and they should be encouraged to keep simple statistics of the reasons, why's and wherefore's of what happens.

At the time I was considering the final draft of this Address, I read the pre-print of a paper for this Conference entitled "Methods Employed in the Production of Heavy Iron Castings." I was impressed by the authors' views being so similar to those I had already written down for the latter part of my address, and by their reference to "analytical approach." I commend this paper, remembering that its principles are applicable to the large jobbing foundry making large castings or to the small jobbing foundry making any size of casting.

Do not let us hear any more "Well, of course, we are a jobbing foundry" in the manner which indicates that there is nothing that can be done. The jobbing foundry is the most interesting of all. Logical thought, and (do not be frightened of the words) "scientific management" can be applied and should be applied to it just as much as any other foundry. It will train the craftsmen of the future and it will absorb those who have been trained.

I finish, therefore, with the thought that many types of skills, simple but specialist, comprehensive from the craftsman, are needed to make the wide range of foundry products. Let us, therefore, accept these different types of skills rather than be afraid that one is replacing the other. The diverse products of the industry must be made in quantity or individually. It is those foundries having a diversity of production to which I think some guidance is still necessary.

SMITH'S DOCK COMPANY, LIMITED, South Bank-on-Tees, has received an order from the Burnett Steamship Company, Limited, Newcastle-upon-Tyne, for a cargo steamer of 5,500 tons d.w. for delivery in three years' time.

Leaders of the Industry

PROFESSOR R. J. SARJANT

Professor R. J. Sarjant, O.B.E., D.SC., delivered the Edward Williams Lecture at the Annual Conference of the Institute of British Foundrymen at Buxton this week. The lecture is entitled "Fuel and Metals," and is published on the adjoining pages.

Professor Sarjant graduated at the Royal College of Science, South Kensington, passing afterwards to the Department of Chemical Technology of the Imperial College where, as research assistant to the late W. A. Bone, he studied fuel technology, chemical engineering and refractories. At the instance of Sir Robert Hadfield, he became the first fuel technologist specifically appointed to invesigate fuel problems peculiar to the iron and steel industry. Professor Sarjant was a pioneer in the early application of techniques now in everyday use in a wide range of industry. Later, the scope of his activities broadened to embrace a much wider range of the technical problems associated with

the industry, and he achieved a considerable reputation in the fields of metallurgy and refractory materials as well as in fuel engineering. In 1947 he was appointed to the Chair of Fuel Technology at the University of Sheffield. His major contributions to the proceedings of the leading scientific and technical institutions number over 60. They cover a wide range extending from the more academic aspects of coal constitution and the intricacies of heat transmission to the practical problems of the workshop. Professor Sarjant is a Fellow of the Institute of Fuel and of the Institution of Metallurgists and a member of the Institution of Mining Engineers. He was awarded the O.B.E. in 1945 in recognition of his work for fuel efficiency, and he was the Melchett Medallist of the Institute of Fuel in 1950.

Golf Competition.—Last Friday afternon, Bradley & Foster Limited of Darlaston entertained a number of foundrymen at their annual golf competition for the T. A. McKenna cup at Whittington Barracks Golf Course, near Lichfield. Despite somewhat inclement weather, a very enjoyable afternoon was spent, followed by tea at the Golf House. In the evening, the 26 players were joined by an equal number of other guests as well as members of the staff at dinner in the George Hotel, Lichfield. Here, the cup was presented to Mr. H. Darville, of Rudge, Littley, Limited, who returned a nett score of 68. Dr. J. E. Hurst, managing director of the Company, presided.

I.B.F. "Edward Williams" Lecture

Fuel and Metal*

By Professor R. J. Sarjant, O.B.E., D.Sc.

The Author introduced his address on Wednesday morning at the Buxton Conference by saying that to take part in the commemoration of the services to the Institute of an outstanding and highly-respected former president by means of a lecture is indeed a privilege as well as an honour. To follow, however, such a galaxy of talent and eminence as constitutes the list of previous lecturers is to be confronted with an awe-inspiring task. Mr. C. E. Williams' interests were both wide and deep. His direct association with the foundry industry was concerned in an admirable manner with the development of high-class foundry products. His influence and the interpretation which has been given by the Institute to this memorial prompt attention, not only to practical measures of more immediate importance to the industry, but also to the scientific advancement of knowledge that must lie at the basis of its future progress. Accordingly it is the objective of this discourse to consider the practical and scientific aspects of foundry practice upon which some of the Author's present activities may have a bearing.

Coke in Metal Melting

To the foundryman, the most important fuel is undoubtedly coke. The requirements of his metal-melting practice demand specific properties in the fuel used. Ideally, it must be capable of producing the highest practicable temperatures. There must be uniformity of performance, and there are metallurgical requirements as to temperature of casting and chemical and physical properties of the metal produced, which are of prime importance. Other essential criteria of efficient practice are a required rate of output determined by the temperature levels operating, and economy of materials, which is dependent on both plant and process.

Contrast of Cupola and Blast-furnace Requirements

In considering the characteristics of the fuel demanded for its satisfactory service in the cupola, one cannot exclude some consideration of that important body of knowledge which has been built around the question of the physical characters of blast-furnace coke. There is an equivalence of requirement in the need in both cases for a specific property called "hardness" with absence of fissuring, and stress too upon the importance of size and uniformity of quality.

In the combustion of coke, the reactivity to oxygen is an important criterion in the determination of the operative temperature of the fuel bed. Again, in both processes there enters, perhaps to varying degrees, the reactivity of the coke to carbon dioxide, since the product of this reaction, namely carbon monoxide, may lead to loss of potential heat in the effluent gases. In the blast-furnace these factors may not be of equal significance for two reasons; one, that the temperature of the melting zone may be above the temperature at which the coke may be able to burn to carbon dioxide; the other, that the carbon monoxide produced is an essential element in the major function of the furnace, namely the reduction of iron ore.

* Presented to the Institute at the Annual General Meeting in Buxton this week. The lecturer is Professor of Fuel Technology, University of Sheffield.

Shortage of Coking Coals and the Implications

In the production of the best metallurgical cokes, there enters an important element in the parentage of the constituents of the coking slacks. Whilst modern research is being devoted earnestly towards bringing into service the less-effective coking coals, in order to widen the range of availability of serviceable coals, the situation, that reserves of good coking coals are being rapidly depleted, cannot be ignored. At the same time, therefore, there are problems of prime urgency facing both the coke

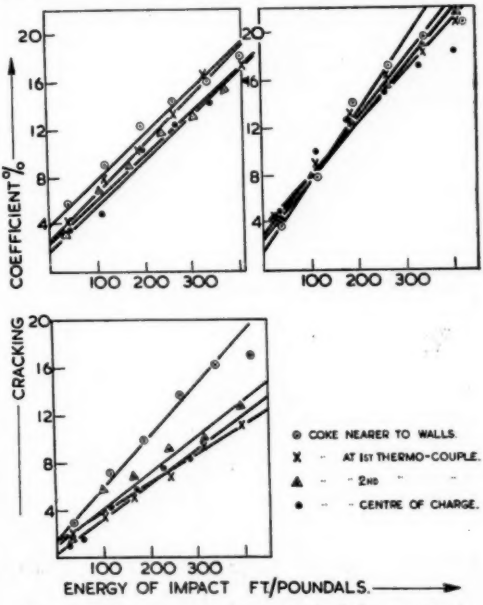


FIG. 1.—*Response to Impact of Cokes made in Experimental Oven from Coals from Wombwell, Upper Mountain Mine, and Maltby. Degradation Factor is derived from the Slope of the Lines.*

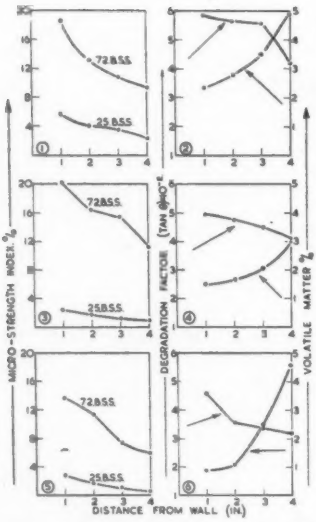


FIG. 2.—*Micro-strength Index and Degradation Factor of Cokes at Various Distances within the Oven, made from Coals*:—(1) *and* (2), *Upper Mountain Mine Coal;* (3) *and* (4), *Wombwell;* (5) *and* (6), *Maltby.*

manufacturer and the foundryman. It is a welcome sign of the times that these two parties are collaborating in works' scale investigations into the assessment of the pertinent factors of cupola operation and the determination of the properties which are really required in a good foundry coke. It is necessary to be able to specify the needed properties in the coke for the guidance of the coke manufacturer.

It is perhaps remarkable that no satisfactory solution of the problem of foundry coke specification has yet been found. The A.S.T.M.* specification goes back to 1916, and yet the question has been so beset with cupola variables and conflictions of evidence as to the validity of such specifications that the A.S.T.M. abandoned attempts at revision in 1947. In this country, opinion at present is equally sceptical.

The difficulties do not lie in any inability to sample the coke and apply to it a whole series of detailed tests. There have been developed over the last few decades a multitude of such tests. The problem lies rather in the determination of the required combination of properties and the significance to be applied to the inter-relation of the individual tests. Any combustibility test, for example, if such must be used, is limited in its applicability since so many factors come in to the question of assessment, namely rate of combustion, dimensions of the fuel bed, particle size, concentration of oxygen in the gas stream and temperature. A test which serves to predict behaviour at one range of temperature will not necessarily predict also behaviour within another range. In the cupola this question of temperature becomes a major factor, which is determined primarily by the reactivity of the coke for a given set of operative conditions. A low reactivity is required in foundry coke to give (i) high thermal release, since it involves preferential combustion to CO_2 rather than CO, and (ii) delay in the solution of carbon in carbon dioxide.

As far as may be evident at present, the critical requirements for a foundry coke are,

(i) Uniform size;
(ii) high strength and hardness;
(iii) low reactivity, and
(iv) low ash and sulphur.

Of these, popular opinion tends to regard size and strength as the prime criteria at present, but the Author's view is that the importance of reactivity has been under-estimated, because the specific relation of reactivity to temperature has not been sufficiently appreciated. Our attention at the University of Sheffield has been particularly drawn to this subject in a wider programme of research, which has had as its objective the contribution of fundamental knowledge on the mechanism of coke formation. Such an objective naturally includes the study of the coal involved, the operative conditions of carbonization and the properties of the resultant coke.

Constitution of Coal

In the first category, investigations have now entered a field in which the Author had the privilege of working with W. A. Bone at South Kensington on the solvent action of coal with pyridine.[1] Since those days, numerous investigations by many workers have followed in that field.[2] To-day the problem still remains unsolved.

In realizing that the most practical outlook on fuel problems must be supported by an adequate treatment of their fundamental aspects, there has been introduced into this part of the University's research programme a new combination of older and newer techniques. The older solvent-extraction, speeded up by the use of ultrasonic treatment, has been followed by the use of chromatographic adsorption and infra-red spectrometry. The objective has been to obtain all the possible information about the range of coals being brought into service in the investigation of the relation between carbonizing conditions and the properties of the resultant coke. In the earlier work

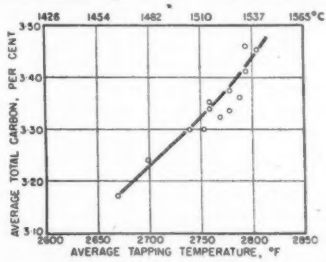


FIG. 3.—*Relation between Carbon Content and Tapping Temperature* (*Krause and Lownie*).

* American Society for Testing Materials

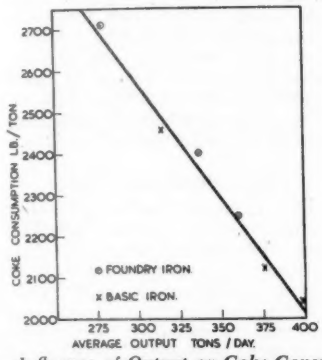


FIG. 4.—*Influence of Output on Coke Consumption in the Blast-furnace* (*Richards*).

carried out some few years ago, the solvents used were phenol and chloroform. Now, with the application of the ultrasonic booster, we have had to return to pyridine. Use of the earlier solvents followed by chromatographic separations with activated alumina in the adsorption column revealed interesting tentative relationships when the infra-red absorption technique was applied to elutriants from a critical group of coals. These had been chosen on the basis of the knowledge of the behaviour of the industrial cokes, made from the coals, when used in blast-furnaces, cupolas and lime kilns. The earliest work in this programme was carried out by D. K. Datta, the development of the ultrasonic technique by A. G. Mertins, and now Dr. W. A. Kirkby and J. R. A. Lakey are working on a range of coals, confining attention particularly to the separate banded constituents, the clarain, vitrain and durain as well as the coking slack. Interesting relationships are being found between coal extract, rank and the coking characters of the banded constituents. In many respects they are confirming and extending Datta's conclusions, finding more complex spectra in coals of higher rank, as well as significance in the intensity of the absorption bands.

The subject is rather academic for an audience of practical foundrymen interested primarily in the application of coke in an industry already sufficiently burdened with metallurgical complexity. The work requires skill of a special order and obviously results in such a specialized field must emerge slowly. Nevertheless it must interest the members of the Institute to know that such lines of inquiry are being pursued, since the ultimate results will have a bearing it is hoped on an important material they use.

Factors Governing the Properties of Coke

It is known that many factors associated with the coal are contributory in determining the properties of the resultant coke. Thus there are the well-known chemical factors, composition, the nature of the banded constituents and the mineral impurities, physical factors such as the size of the coking slack, specific-surface, friability, bulk-density, plastic and swelling properties and pressure development on heating. Again, a weathered coal is useless for coke manufacture. The coke-oven manager has his problems in the oven conditions, in the uniformity of heating, the nature of the time/temperature cycle during carbonization and the multitude of mysterious changes going on inside the oven. An extensive literature exists on this subject alone. Not the least important, the coal preparation plant is a contributory factor in the supply of properly sized coal, of adequate cleanliness and correct moisture content.

Correlation of Carbonizing Conditions and Coke Properties

For investigations of this character two carbonization units have been constructed at the University, one a low-temperature retort and the other an experimental coke oven. In these units, investigations are made of the influence of coal characteristics, temperature and time in the properties of the resultant coke. We are particularly interested in the behaviour of the coal as it passes through the so-called " plastic range," that is, when the coal is melting, and in an imaginative sense the foundations of coke structure are being laid. For this purpose, an effective technique for measuring the detailed changes of temperature within the oven has been developed as well as a new method of thermal analysis, based on the finite difference equation used in our earlier work on the variable flow of heat. The application as it is used in this problem was worked out by our mathematician, P. H. Price.[3]

Since the carbonization work applied in a University laboratory must be limited in size, it has only been possible to go up to charges of the order of 100 lb. of coal, and therefore the normal methods

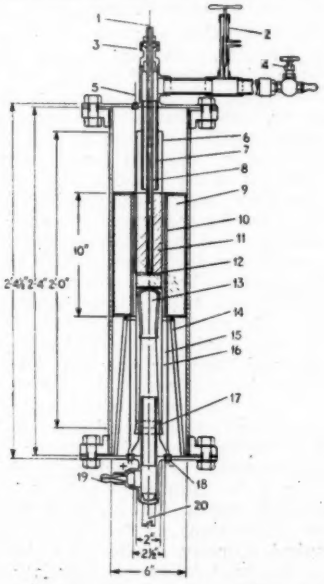


FIG. 5.—*Apparatus for determining Coke Reactivity.*

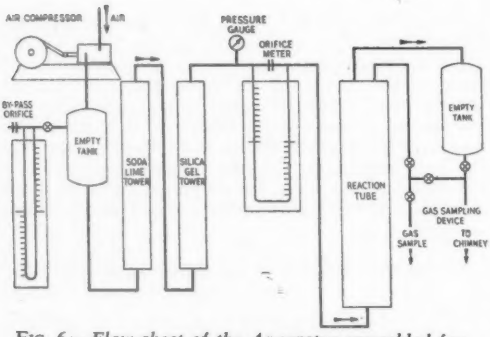


FIG. 6.—*Flow-sheet of the Apparatus assembled for Reactivity Test.*

of testing the physical properties of the coke have not been applicable. New methods suited to the conditions have had to be found. It has long been apparent that the tests which are used to determine the physical properties of coke are largely empirical. As long ago as 1920, the Author had applied the American drop-test to the routine testing of coke in works' practice. This particular machine was probably the first machine adopted as a routine appliance in this country for the purpose. Long before reports were appearing from other research organizations to indicate its value as a means of indicating in a broad way what might serve as a hot melting coke, this relationship had been established in the works with which the Author was associated, with a recognition also of the limitations of the test as a scientific index of the industrial value of the coke.

Impact Testing

Our present objectives are, however, more fundamental in character. We are seeking for causes rather than for indicators of effects. This inquiry led to the development of an impact test in which the energy of translation of the coke against a breakage plate could be measured accurately and varied over a range. It could thus provide a truly scientific criterion of the impact energy required to produce breakage on a comparable basis. A machine, operated by means of a powerful spring, the compression of which could be varied and accurately measured, was developed by J. E. Littlechild. This spring operates a light-alloy tray from which a suitable sized sample of coke is projected against a metal plate. The shattered coke falls back into the tray. It may be subjected to further impact or it may be removed from the tray for size analysis. With increasing impact energy, the criterion which expresses a linear relationship with energy input, is a value named the cracking coefficient. It involves the square of the weights of the particles involved. Plots of impact energy *v.* the cracking coefficient are shown in Fig. 1 for samples of cokes taken from various distances within the walls of the experimental oven. The slope of the curve is an index of the physical property of the coke revealed by this test. It has been called the degradation factor and is expressed in terms of per cent. degradation per ft. lb. of impact energy applied. The relations between the results of this test, the micro-strength index of the machine developed by the Northern Coke Research Committee,[4] the position of the sample in the oven and its content of volatile matter for a number of experimental coals are shown in Fig. 2. The results show the importance of attaining uniformity of conditions in the oven.

Reactions in the Cupola

Conclusions from the calculation of the equilibrium constants, from which variations of gas composition with temperature may be deduced, indicate that only such properties of coke are important in determining the quality of the iron that may affect the temperature in the crucible[5]. Again work by Johnson and MacKenzie[6] on foundry cupolas has shown that the quantity (C + 0.3 Si) is nearly a linear function of hearth temperature. Krause and Lownie[7] have shown that there is a close relationship between carbon content and tapping temperature (Fig. 3).

Useful Deductions from Blast-furnace Practice

Tu, Davis and Hottel[8] found that the rate of combustion of carbon at temperatures prevailing in the blast-furnace is roughly proportional to the absolute temperature. In the cupola, the rate at which carbon is consumed is a function of rate of oxygen supply and the conditions in the shaft, particularly that of penetration. The coke must be burnt at a rate in agreement with the mass of the coke added between charges. Otherwise, the bed height will change and conditions of stability be upset, giving rise to unsuitable composition of the iron. With this limitation in mind, certain other features, namely the relationships between rate of driving, temperature and coke quality observed in blast-furnaces are noteworthy. Thus the blast-furnace is—like many other machines—more

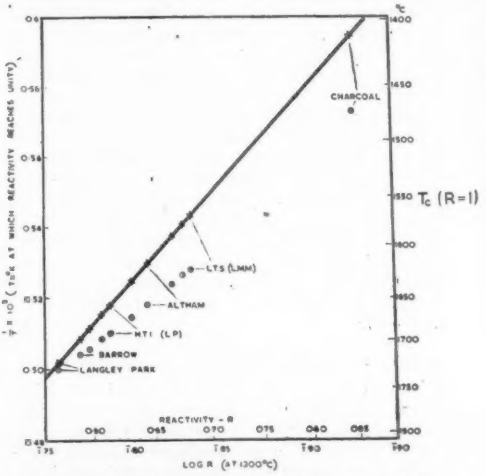


FIG. 7.—*Relation between Reactivity at* 1,300 *deg. C. and Temperature at which Reactivity ceases to have Influence on the Fuel-bed Temperature.*

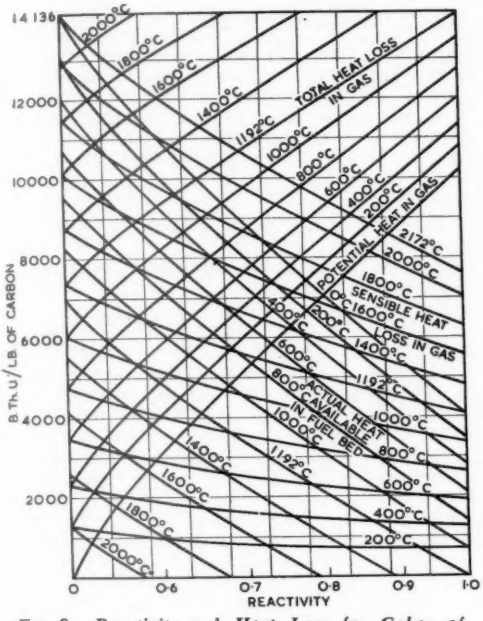


FIG. 8.—*Reactivity and Heat Loss for Cokes of Different Reactivity based on the Determination of Reactivity at* 1,300 *deg. C.*

efficient the harder the driving. That master of metallurgical science of his day, J. W. Richards,[9] produced the interesting data shown in Fig. 4. Data relating to blast-furnace practice published by Brooke, Walshaw and Lee[10] and afterwards correlated by Mayers and Landau[11] showed that production rate was significantly related to shatter-test or to Cochrane drum test, coke-rate to shatter-index, production rate and blast temperature. That the hanging tendency in a blast-furnace may be associated with flooding of the coke column below the fusion zone of the furnace has been recently suggested by Elliott, Buchanan and Wagstaff[12]. The interesting point from their analysis of the problem was that flooding tendencies would be increased by higher gas velocity, by a more viscous slag and decreased by large uniform-size coke. The relationship of size grading to performance has been repeatedly shown[13, 14, 15, 16]. Different sized coke may be used, but size grading must be close, giving good permeability.

Less systematic investigation of this character has been made into cupola practice, but the above deductions are apparently applicable to such for Blayden, Noble and Riley[17] working with a small experimental cupola showed that in agreement with practice in full-scale furnaces the use of high blast rates and large coke tended to improve melting efficiency. Small coke produced the endothermic production of carbon monoxide. Beehive coke gave the best results. The significance of high mechanical strength in the coke is thus abundantly apparent. Increase of coke size has also been shown to have certain metallurgical effects, thus (1) less sulphur pick-up, (2) increase in silicon loss, (3) decrease in carbon pick-up, (4) increase of manganese loss and (5) speed of melting[18].

Flow Factors in the Cupola

The significance of a size of coke of uniformity and defined value related to the diameter of the cupola may be deduced from the known behaviour of gases flowing through packed solids. It is recognized that the tuyeres must have critical dimensions to give adequate penetration and distribution of the air. From fundamental investigations[19] it is known that bed voidage plays an important rôle. Operating with a third power relationship, a small change in void volume produces a marked change in the resistance offered to the flow of gas. The surface area per unit volume, which increases as the particle size decreases, affects both the resistance to flow and the character of the combustion. As a rough approximation, the resistance to flow will depend directly upon some function of gas velocity and inversely as the diameter of the coke for properly-sized fuels. There is a relation between metal temperature, melting rate per unit of cupola cross-sectional area, and air rate[20, 21, 22]. Differences in

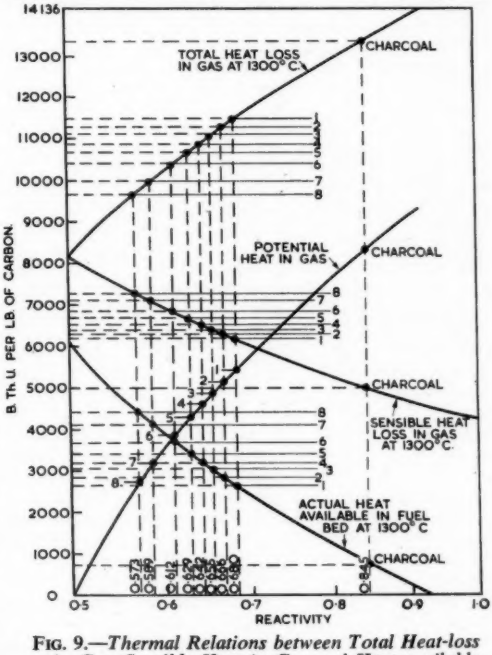


FIG. 9.—*Thermal Relations between Total Heat-loss in Gas, Sensible Heat in Gas and Heat available in Fuel Bed for Combustion of Coke in Air.* (1) *Lower Mountain Mine* (*Carbonized and Reactivity at* 800 *deg. C.*); (2) *Lower Mountain Mine* (*at* 1,030 *deg. C.*); (3) *Upper Mountain* (*at* 820 *deg. C.*); (4) *Altham* (*Commercial M.M.*); (5) *Thurcroft* (*at* 1,060 *deg. C.*); (6) *Langley Park* (*at* 1,000 *deg. C.*); (7) *Barrow* (*Commercial Thurcroft*); (8) *Langley Park* (*Commercial*).

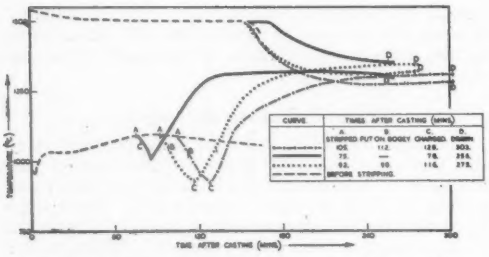


FIG. 10.—*Temperature/Time Curves for an 8½-ton Ingot from Casting to Drawing for Rolling. Dimensions, 43½ by 25¼ by 70 in. C = 0.09, S = 0.03, P = 0.014, Mn 0.34 per cent. Mould, external, 57 by 39¼ by 74 in. Temperatures at the Centre (Upper Series) and Mid-centre of One Side (Lower Series).*

reactivity cause a shift with respect to metal temperatures.

Noteworthy is also an attempt to determine the coefficient of heat transfer in a cupola and the time required to melt the metal. This, a truly formidable task, has been made by Czyzewski[23] following up the work of Osann[24]. Based on experimental trials, the coefficients of heat transfer and the melting times have been related to the gas velocity, temperature, diameter of the charged pieces and of the cupola and the thermal constants of the charge.

Coke Reactivity

It is recognized that it is relatively easy to obtain a readily-combustible coke, that is, one readily ignitable and able to keep burning with a low draught. The property may even be enhanced by the addition of catalytic agents such as sodium carbonate, but a really high-quality foundry coke has almost the rarity of a precious mineral. What is the property which produces a really hot melting coke? This must be considered as being in addition to the very desirable physical properties already discussed, and of course the obvious desideratum of purity. It is the property of reactivity interpreted as a capacity of the coke to burn to CO_2 rather than to CO at a high temperature. A new test for reactivity considered from this standpoint was recently developed in our laboratories, the investigator being S. Banerjee.[25] It consists in determining the composition of the gas evolved under standard conditions in a small fuel-bed, maintained at a constant measured temperature by means of an external heater, and fed by preheated air at a predetermined temperature (Figs. 5 and 6). A convenient expression for reactivity is the ratio of the weight of the carbon content of the gas at the sampling point (derived from the content of oxides of carbon) per unit volume of ingoing air, to the weight of the maximum carbon content of the gas in the same units which would be attained by complete conversion of carbon dioxide to carbon monoxide. Allowance is duly made for the effect of the volatile matter in the coke, and it may be shown that the relative reactivity is equal to the ratio, $\frac{CO_2 + CO}{2CO_2 + CO}$ where CO_2 and CO are determined from the volume percentage analysis of the dry stack-gases.

In the range of temperature 1,200 to 1,400 deg. C. a strong correlation between relative reactivity and coke-bed temperature was observed, which fitted the equation, for a Langley Park coke,

$$R = \frac{Tc - 719.4}{1000} \qquad (1)$$

where T_C = temperature in deg. C. and R = reactivity.

The data were alternatively fitted to an Arrhenius equation of the form

$$\log R = -\frac{1810.5}{T} + 0.9151 \qquad (2)$$

where T = temp. deg. K.

These two formulæ lead to some revealing interpretations if the curves are extrapolated to a value of reactivity = 1, when the reacting gas is completely converted to carbon monoxide. We thus arrive at an index of the maximum practicable temperatures attainable without preheat. The results of reactivity tests on a series of industrial and experimental cokes are shown in Fig. 7. The plain line shows the values of the temperature at which reactivity reaches unity derived from the Arrhenius equation (2) plotted against reactivity determined at 1,300 deg. C. The points show similar values of maximum attainable temperatures extrapolated

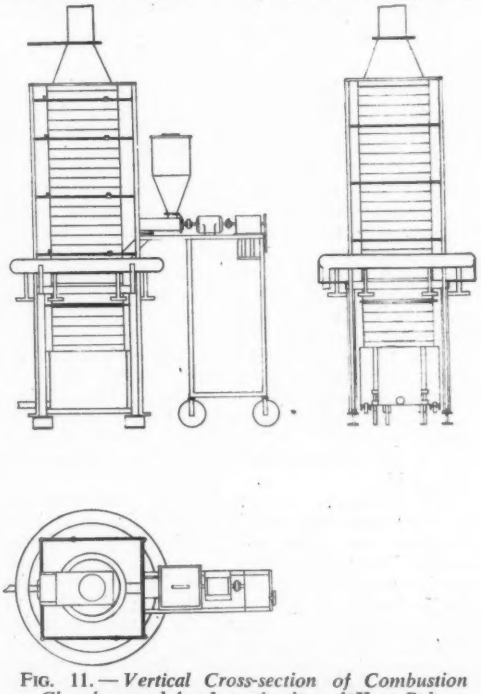


FIG. 11.—*Vertical Cross-section of Combustion Chamber used for Investigation of Heat Release from a Coal Flame.*

from equation (1). The discrepancies are to be expected and the matter has been pursued further.

The practical significance of these results is made more evident from the data given in Fig. 8, in which the reactivity is expressed in terms of the sensible and potential heat in the gas and the heat available in the fuel bed for melting at any particular temperature. Fig. 9 applies to the conditions in the fuel bed at the temperature at which the reactivity has been determined. Fig. 8 shows the availability of the heat at other temperatures corresponding to any given gas composition. It serves to show the measure of the greater availability of the heat in the fuel bed for metal melting with cokes of low relative reactivity. The addition of heat by external means, thus the introduction of preheat in the charge, or loss externally from the melting zone only affects the demands to be made upon the coke. It does not affect the capacity of the coke to evolve in the melting zone available heat. The significance of the maximum temperature, or that at which the coke will only burn to carbon monoxide, is perhaps even more important, since it indicates that there is a limit to the usefulness of cokes of greater reactivity unless external means are used to boost temperature levels in the cupola such as that of preheat.

Influence of Gas Velocity on Reactivity

In the test of reactivity described, the rate of flow of the air was closely controlled to a standard value of 0.2 cub. ft. per min. at 0 deg. C. and 760 mm. pressure. It is to be expected that the character of the reactions in the fuel bed must be affected by changes of rate of flow. Accordingly, further investigations are being made into the influence of this variable. It is desired, of course, to pursue such inquiries into the range of temperature of such great practical importance, namely, the range 1,600 to 1,700 deg. C. At these temperatures, experimental difficulties become increased. Fusion of ash introduces interference and limitations in the materials used for the apparatus offer formidable obstacles. For this purpose, it has been necessary to resort to platinum for the containing vessel and to use the oxy-acetylene flame for obtaining the requisite temperatures. Experiments at lower temperatures by R. Smith suggested tentatively that the influence of the air rate was to lower the reactivity at a particular temperature, the reactivity tending towards a limit with increase of velocity, and the relationship being expressed by a hyperbolic function of the velocity of the gas. The explanation lies probably entirely in the mode of transport of oxygen to the reacting surface, and not necessarily in any specific character of that surface. This is in keeping with the known increase of temperature of combustion with increase in rate of air supply.

The important conclusion of this work is that in the cupola, and possibly also in the blast furnace, rates of melting and temperatures of the metal are influenced materially by coke reactivity, and that increased velocity of blast tends to produce the equivalent of a fall in reactivity for a particular temperature. A significant remark was made to the Author one day by Dr. Dunningham, that he and his colleagues believed that in the cupola and the lime kiln specific maximum temperatures were attainable by particular cokes, but that they had no means of either confirming the belief or assessing the temperatures. If such a determination can be made practicable, it will be of considerable value in the evaluation of coke. It was further evident in our work that there was a specific value to be placed in the parentage of the coal, which must be taken into consideration in further efforts to improve the economic value of metallurgical cokes.

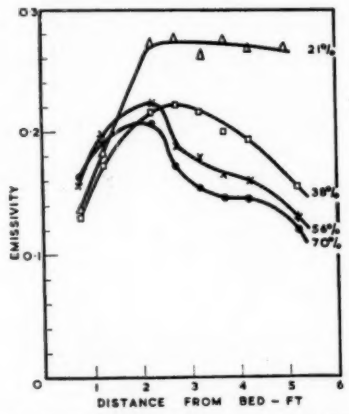


FIG. 12.—*Effective Emissivity* v. *Excess Air at Successive Points along the Travel of the Gases in the Combustion Chamber.*

Mapperley washed slack, combustion rate 12 lb. per sq. ft. per hr.

Preheat and Blast Humidity

From the above conclusions, it would also appear that the disability of a high reactivity can receive

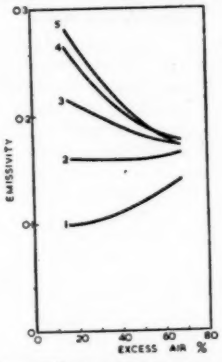


FIG. 13.—*Mean Effective Emissivity* v. *Excess Air for Various Sizes of Combustion Chamber.*

Mapperley washed slack, combustion rate 20 lb. per sq. ft. per hr. Heat input 200 × 10^3 B.Th.U. per sq ft. per hr. Number on curve indicates size of combustion chamber in cub. ft. per sq. ft. grate.

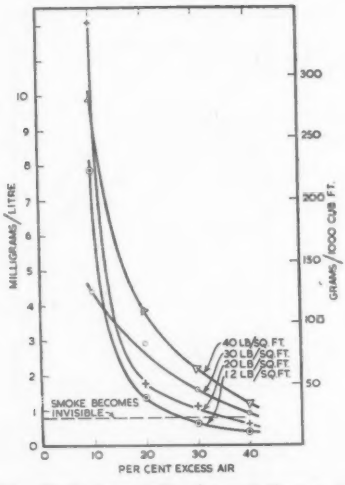


FIG. 14.—*Variation of Smoke and Excess Air and Different Rates of Combustion.*

compensation from an increase in any condition that may serve to add preheat or reduce endothermic demand in the metallurgical reactions.

The significance of humidity is to cause reduction of carbon with the evolution of carbon monoxide and hydrogen. The decomposition of 1 lb. of water vapour requires the burning of 0.37 lb. of coke to produce the heat required for the reaction, and 0.06 lb. of coke to heat the water vapour to the reaction temperature. Krause and Lownie[7] have shown in a small experimental cupola that an increase of moisture from 27 to 219 grains per lb. of air gave a loss of 86 deg. C. (135 deg. F.) in tapping temperature, reduction in carbon from 3.45 to 3.17 per cent., a lower melting rate and increased loss of silicon and manganese, resulting from more oxidizing conditions.

Hot-blast Cupola

Theoretically this device should produce conditions which counteract the adverse effect of inferior fuel, but it obviously introduces complexity where the ideal should be simplicity and ready reproducibility of results. The first application of the hot-blast cupola goes back to the days of the development of the hot-blast stove in blast furnaces. Many types have been tried and literature is not by any means barren of record.[21 22 26] Thus the claims made as between cold and hot-blast cupolas are very remarkable. At Aachen[27] efficiencies of 55 to 65 per cent. have been stated to have been obtained in an experimental cupola. The most hopeful development lies in the use of the separately-heated stove. The limit in the reduction of the coke ratio would appear to be at about 8 per cent. with a blast temperature of 600 deg. C.

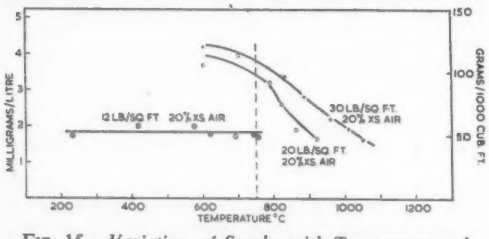


FIG. 15.—*Variation of Smoke with Temperature of the Wall.*

$$\frac{\text{Volume of combustion chamber in cub. ft.}}{\text{grate area in sq. ft.}} = 6$$

Oxygen Enrichment

Amongst the remaining features of possible future development is the use of oxygen enrichment. Until cheap oxygen appears as a reality (at present a somewhat remote possibility, since half the cost lies in the cost of power) it would be too costly to operate continuously. Nevertheless, it has proved to be of service for intermittent use for "trouble shooting" and "boosting" at starting-up. Whilst an enrichment of 4 per cent. has been found to double melting rates, refractory wear could be disastrous.[28 29]

The final most desirable requirement would appear to lie in developments towards coke of the maximum unreactivity.

Heating and Furnace Investigations

This discourse would not be complete without some brief account of the impact of certain scientific inquiries in the domain of furnace technology on the practice in the foundry of fuels other than coke. Only a brief insight may be given here of the approach that is being made.

Investigation of the Variable Flow of Heat in Metal and Refractory Masses.—The sceptical may not recognize that it is possible to calculate the temperature inside a mass of steel, or within a refractory mass such as a furnace wall or a sand mould. Considerable progress has been made in regard to the two first named, and the last has been undertaken as a practical problem capable of solution by this means.

The data shown in Fig. 10 relate to the thermal history of the centre of an ingot and that of the temperature of the mid-point of one side at the surface. It has been entirely determined by numerical integration[30] by M. R. Slack working in our department at the University. It shows the temperature condition at which the ingot was stripped, that at which it was transferred to the soaking pit, and provided an indication is obtained of the nature of the rise of the surface temperature of the ingot, the difference of temperature between the surface and the centre may be derived after successive intervals of time. Other calculations have shown that the time of gap formation has a negligible effect on the temperature distribution after stripping and a value of three minutes was chosen as a most probable value. By comparison with ingots which are just too cold to roll, it has been found possible to determine the standard of temperature saturation at which an ingot should be drawn. Thus methods have been developed which may have an application in foundry practice. An immediate problem is that of the dry-

ing of a sand mould, about which much may be learnt by combining the theoretical approach with some practical drying experiments. The nature of the heat-transfer coefficients in a stream of moving gases such as one would find in a foundry drying stove, both in terms of convection transfer and gas radiation, is known with some precision.[31] The problem of the cooling of a mass of solidifying steel has been found capable of solution. There is no reason why the heat transfer through a mass of drying sand should not be as readily obtained, provided the nature of the diffusion of the water vapour can be assessed. This should be subject to elucidation in the experimental approach.

Heating Effects of Coal Flames and Smoke Abatement.—In the combustion chamber operated by a mechanical stoker and shown in Fig. 11, observations have been made by E. Hammond on the character of the heat release from coal flames and its transmission to the walls of the chamber, which is instrumented to measure the heating effect. In Fig. 12 is shown the variation of effective emissivity of the flame along the combustion chamber with variation of excess air, and in Fig. 13 the mean effective emissivity *v.* excess air is plotted for various sizes of combustion chamber. Data may be deduced from these observations to predict what may occur in industrial plant. It has also been shown that coal may be burnt completely with relatively low proportions of excess air, provided the air is introduced at a high velocity in a number of fine streams.

Applying a thermal precipitator to measure the smoke, the relation between smoke emission, rate of combustion, excess air and temperature of the wall of the combustion chamber are shown in the diagrams (Figs. 14, 15). An important conclusion from these results is that it is impracticable to avoid smoke emission where the flame is adjacent to a refractory surface at a temperature below 750 deg. C. These observations were made by A. Preston.

A further interesting series of investigations into the atmospheres which are needed for the safe heating of the critical steels of the Sheffield trades has just been completed by G. R. Mattocks and is nearing the publication stage. Smoke in coal-firing has been shown to be merely the unwelcome and almost inert attendant of the small quantities of unburnt combustible which in the presence of sulphur may play curious tricks in the formation of a troublesome sticky scale and possibly some decarburization. Small quantities of excess air are of minor importance in comparison with the sulphur content of the steel.

Gas-fired Furnaces.—In the field of furnace design, investigations by D. Smith, at the University, on a towns'-gas-fired experimental furnace, designed to simulate an industrial continuous heating furnace, have shown that a considerable part of the heat transfer within the chamber occurs by re-radiation from the hot refractory surfaces. The basic data upon which the design of such furnaces should be framed are being worked out. This is practicable, because the whole structure of the furnace is virtually a calorimeter[32]. In such furnaces, the character of the mixing and any turbulence which

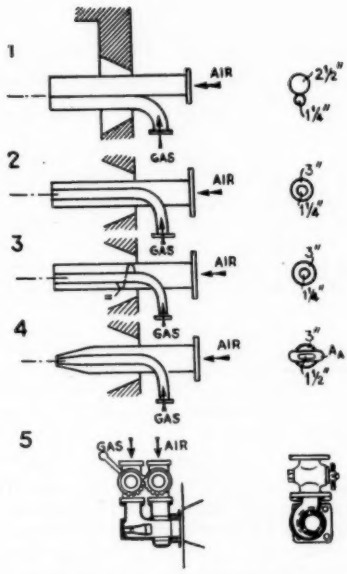


FIG. 16.—*Types of Burners used in Furnace Experiments by R. Pistor.*

Velocity of gases corresponding to a flow of 35m³ per hr. gas 130m³ per hr. air

(1)	A_A=34.2 cm², A_G=9.6 cm²	V_A=11.0 m/s, V_G=10.1 m/s
(2)	A_A=34.8 cm², A_G=9.6 cm²	V_A=10.8 m/s, V_G=10.1 m/s
(3)	A_A=34.8 cm², A_G=9.6 cm²	V_A=10.8 m/s, V_G=10.1 m/s
(4)	A_A=16.6 cm², A_G=3.8 cm²	V_A=22.6 m/s, V_G=25.6 m/s
(5)	A_G=5.0 cm²; A_G+A=38.5 cm²;	V_G=19.5 m/s, V_{GA}=11.9 m/s

determines the character of the flame is usually introduced by the particular design of the burner used. The experimental curves by Pistor[33] of the burners shown in Fig. 16 are given in Fig. 17. This shows the temperatures of the flame from coke-oven gas as determined by a suction gas pyrometer at various distances along the furnace chamber for the different types of burner. With rapid mixing, a non-luminous flame is produced, which radiates most of its heat in the infra-red region of the spectrum from the CO_2 and H_2O molecules produced. The emissivity of the gas is low, of the order of 0.2, and the temperature high. The converse happens with slow mixing and the maximum temperature of the products of combustion occurs at some distance inside the chamber. The temperature is low and the emissivity high—0.7; hence, such flames are more favourable for the uniform heating of castings in annealing.

The Trivial Round.—The many minor matters that enter into the fuel problems of a foundry

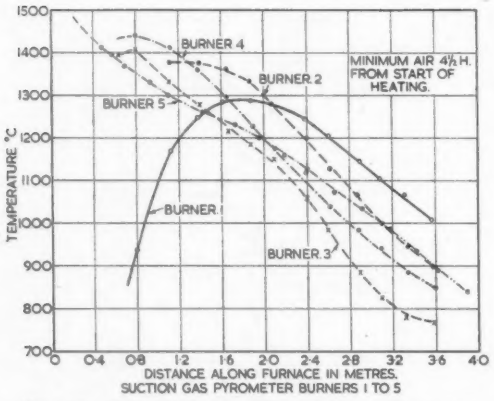


FIG. 17.—*Relation between Burner Type, Temperature and Distance along Furnace Chamber (Pistor).*

are questions of organization and routine detail, questions as to whether all the lessons abundantly evident in a field full of fruitful example have been gleaned and applied. It may perhaps be said of the repeated exhortation one hears in regard to these matters to-day that never has so much been said by so many, and listened to and acted upon by so few. Perhaps it is an application to social science of an analogy of the Le Chatelier principle in the form that Nature seeks to resist the changes that are imposed upon her.

One purpose has rather been to seek the fundamental issues upon which the eternal verities of good practice are based, and to invoke the spirit of science in a field that is perhaps as full of intricate technical problems as other more glamorous aspects of industrial activity.

REFERENCES.

[1] Bone, W. A., and Sarjant, R. J.; Proc. Roy. Soc., **96**, 119-136 (1919).
[2] Horton, L., Randall, R. B., and Aubrey, K. V.: *Fuel*, **23**, No. 3, 65 (1944) (with extensive bibliography on the Constitution of Coal).
[3] Sarjant, R. J.: Melchett Lecture for 1950. Journ. Inst. Fuel, **24**, No. 135, 2 (Jan., 1951).
[4] Blayden, H. E., Noble, W., and Riley, H. L.: Journ. I.S.I. (i) **136**, II, 47P (1937); (ii) **139**, I, 75P (1939).
[5] Darken, L. S.: Trans. Am. Inst. Min. Met. Engrs., **140**, 204-21 (1940).
[6] Johnson, H. V., and MacKenzie, J. T.: Trans. Am. F.A., **44**, 178-90 (1936).
[7] Kranse, D. E., and Lownie, Jr., H. W.: Trans. Am. F.A., **57**, 111, 163 (1949).
[8] Tu, C. M., Davis, H., and Hottel, H. C.: Ind. Eng. Chem., **26**, 769 (1934).
[9] Richards, J. W.: Trans. Am. Inst. Min. Met. Engrs., **6**, 372-5 (1917).
[10] Brooke, W. J., Walshaw, H. B. B., and Lee, A. W.: Journ. I.S.I., **134**, 387-311P (1936).
[11] Mayers, M. A., and Landau, H. G.: Am. Inst. Min. Met. Engrs., Feb., 1941.
[12] Elliott, J. F., Buchanan, R. A., and Wagstaff, J. B.: Am. Inst. Min. Met. Engrs., Preprint, Pittsburgh, March 31, 1952.
[13] Marshall, D. F., and Wheeler, R. V.: Journ. I.S.I., **127**, 87-113 (1933).
[14] Braunholtz, W. T., Nave, G. M., and Briscoe, H. V. A.: *Fuel* **8**, 428-37 (1929).
[15] Wagner, A.: *Stahl und Eisen*, **45**, 929-35.
[16] Hollinderbaümer, W.: *Giesserei*, **22**, 73-5 (1935).
[17] Blayden, H. E., Noble, W., and Riley, H. L.: Journ. I.S.I., **136**, II, 25P (1937).
[18] Bowers, J. A., and MacKenzie, J. T.: Trans. Am. F.A., Oct., 1937, 293.
[19] Ergun, S.: Ind. Eng. Chem., Anal Edition, January, 1951.
[20] Wright, C. C.: *Iron Age*, Aug. 12, 1948, 72.
[21] Vial, F. K.: Economics of Cupola Operational Control.
[22] Longden, E.: Trans. I.B.F., **39**, A. 148 (1945-46).
[23] Czyzewski, N.: Annales de l'Academie Polonaise des Sciences Techniques, **7**, 49 (1939-45).
[24] Osann, B.: Metallurgische Bietrage zur Kenntnis der Kupolofen vergange die Giesserei, p, 809 (1931).
[25] Banerjee, S., and Sarjant, R. J.: *Fuel*, **30**, 130 (1951).
[26] Bader, M.: *Foundry*, 104, Dec., 1946.
[27] Piwowarsky, E.: *Die Giesserei*, **30**, 221 (1943).
[28] Higgins, A. K.: *Iron Age*, 72, April 22, 1948.
[29] Harrison, E. N., and Wagner, J. A.: *Iron Age*, May 12, 1949, 98.
[30] Price, P. H., and Sarjant, R. J.: Inst. Mech. Engrs. General Discussion on Heat Transfer, Preprint, Section III, Sept., 1951, 19.
[31] Hulse, C., and Sarjant, R. J.: Journ. Inst. Fuel, **25**, 143, 94 (1952).
[32] Sarjant, R. J., and Smith, D.: Inst. Mech. Engs., General Discussion on Heat Transfer, Section IV, Sept., 1951, 15 (Preprint).
[33] Pistor, R.: Arch. für das Eisenhüttenwesen, 74, 565 (1931).

Scotland Needs a Cheap Grate

Dr. E. A. C. Chamberlain, chief scientist of the Scottish Divisional Coal Board, speaking at a conference in Glasgow on May 29, arranged by the Scottish Women's Advisory Committee on Solid Fuel, said that still more efficient grates with back boilers must be designed for Scotland, and sold at a price that the middle and working classes could afford. It might be desirable for the Government to sponsor a design which could be licensed free to manufacturers for sale at low, controlled prices. The cost of heating water by gas or electricity must be three or four times more than that of using solid fuel.

The use of bituminous coal on "openable" or "closable" stoves had been very unfortunate. These appliances were the most efficient solid-fuel space heaters available, but worked best on anthracite or coke. In Scotland the lack of these, or the lack of storage space for coke when available, had resulted in the burning of bituminous coal. This had damaged the domestic fuel economy campaign and proved very unsatisfactory in the "so-called temporary houses," where the short chimneys could not be cleaned.

Metal Licences for Coronation Souvenirs

Manufacturers of medals and other small Coronation souvenirs will wish to know that the Board of Trade have now decided to license reasonable requirements of copper and zinc alloys for this purpose not only for export, but for the home market. The present severe restrictions on the use of nickel and nickel alloys will, however, continue in force. Applications for licences should be made in accordance with normal procedure to the Regional Offices of the Board. The extent to which licences can be granted will depend upon the availability of the controlled metals. The use of copper and alloys containing substantial quantities of copper should be avoided if any other material (except nickel and nickel alloys) is suitable. The licences will be issued under the Copper and Zinc (Prohibited Uses) (Board of Trade) Orders. A licence will not carry any entitlement to any allocation of metal.

"Dollar Savings Through Standards," a report just published by the Productivity and Technical Co-operation Division of the American Mutual Security Agency, reveals a sharp rise of the standards movement in the United States since the war, especially in the past two years. The survey, the first of its kind, is "an attempt to compile a body of measurable proof in terms of dollars or percentages of net savings and specific economic benefits attributable to standardization." It reports 140 documented case studies, covering 81 industries and industrial products, which the American Standards Association compiled from its 110 trade association and technical society members and some 2,000 company members.

Institute of British Foundrymen

ANNUAL REPORT

May 1, 1951, to April 30, 1952

The year ended April 30, 1952, has been one of exceptional activity for the Institute of British Foundrymen. Not only has the normal work of the Institute been fully maintained and in many aspects increased in scope, but the organization of Institute participation in two international congresses, namely, the International Foundry Congress at Brussels in September, and the International Foundry Congress at Atlantic City which commenced on May 1, came within the period under review.

Finance

Accompanying the report are the income and expenditure account for the year ended December 31, 1951, and the balance sheet at that date. It will be noted that the increased rates of subscriptions which became effective on January 1, 1951, are reflected in a fairly substantial improvement in the Institute's resources, as foreshadowed in last year's report. This improvement, however, has been partly offset by the increase in the cost of practically all items, and particularly printing, in the Institute's accounts. In view of the possibility that the cycle of price increases may be prolonged for some time, it is considered that members should not regard the financial position with undue satisfaction.

Membership

The accompanying tables show the membership at April 30 to be 4,917, the corresponding figure at the same time last year being 4,773. While an increase in the numerical strength of the Institute is consistently achieved from year to year, a much more rapid rise is required if the membership of the Institute is to include the majority of all qualified foundrymen, which is the aim of the Council. An appeal is again made to members to use their personal endeavours to induce all appropriately-qualified foundrymen to become associated with the Institute.

Obituary

The deeply regretted losses by death sustained during the year include the following members who have taken a prominent part in the Institute's activities:—

Edward James Kelly, who was a past-president of the Wales and Monmouth branch. Much of Mr. Kelly's spare time was spent in furthering the interests of foundry apprentices, in the training of whom he was very successful both in the foundry and in technical classes. In 1944 he was awarded the British Empire Medal in recognition of his outstanding work.

Thos. W. Markland, a Lancashire branch member of long standing, who was president of the branch in 1914-15.

G. E. Roberts, J.P., who was a past-president of

TABLE I.—*Changes in Membership*, 1951–1952.

	Subscribing firms.	Members.	Associate members.	Associates.	Totals.
At April 30, 1951	227	1,773	2,149	624	4,773
Additions and transfers from other grades	8	86	165	122	381
	235	1,859	2,314	746	5,154
Losses and transfers to other grades	3	61	133	40	237
At April 10, 1952	232	1,798	2,181	706	4,917

TABLE II.—*Analysis of Membership at April* 10, 1952.

Branch	Subscribing firms.		Members.		Associate members.		Associates.		Totals.	
Birmingham	21	(21)	271	(269)	333	(315)	146	(129)	771	(734)
Bristol	4	(5)	73	(74)	69	(69)	10	(8)	156	(156)
East Midlands	9	(9)	97	(95)	185	(188)	60	(48)	351	(340)
Lancashire	35	(34)	220	(212)	342	(317)	72	(64)	669	(627)
Lincolnshire	1	(1)	19	(19)	54	(58)	15	(11)	89	(89)
London	30	(29)	395	(391)	285	(284)	68	(53)	778	(757)
Tees-side	3	(2)	50	(47)	83	(79)	60	(63)	196	(191)
Newcastle	24	(23)	51	(48)	79	(79)	64	(69)	218	(219)
Scottish	25	(25)	166	(169)	252	(248)	61	(61)	504	(503)
Sheffield	9	(9)	120	(115)	104	(105)	15	(13)	248	(242)
Wales & Monmouth	7	(6)	60	(60)	81	(77)	26	(27)	174	(170)
W.R. of Yorkshire	11	(11)	94	(94)	158	(175)	47	(35)	310	(315)
South African	46	(45)	109	(106)	110	(106)	38	(27)	303	(284)
General	7	(7)	73	(74)	46	(49)	24	(16)	150	(146)
TOTALS	232	(227)	1,798	(1,773)	2,181	(2,149)	706	(624)	4,917	(4,773)

Figures in brackets are totals at April 30, 1951.

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the old Coventry branch, and was a valuable and devoted member of the Council of the Institute for many years.

Arthur Sutcliffe, who was a prominent member of the Lancashire branch for many years. He was awarded the Meritorious Services Medal of the Institute in 1949 in recognition of his many Papers and of his personal efforts to promote the welfare of his fellow foundrymen.

Dr. Guido Vanzetti, president of the International Committee of Foundry Technical Associations, and very highly esteemed by his wide circle of friends amongst the Institute membership.

Robert D. Welford, who was a past-president of the West Riding of Yorkshire branch and an active member of the Institute for many years.

The complete list of members who have passed away is as follows:—

Name.	Grade	Branch	Date joined.
H. Bancroft	M.	Lancashire	1950
J. T. Blackett	M.	Tees-side	1930
R. Brown	A.M.	Scottish	1948
G. C. Clayton	M.	London	1928
J. H. Cooper	M.	Newcastle	1921
R. Dickson	M.	Scottish	1937
B. I. Evans	M.	Birmingham	1946
W. S. Hanson	A.M.	W.R.Y.	1948
W. A. Haswell	A.M.	Newcastle	1945
C. W. Jones	A.M.	Birmingham	1946
J. H. Jones	A.M.	Lancashire	1916
E. J. Kelly	M.	Wales & Monmouth	1931
H. Loxton	M.	W.R.Y.	1912
J. McIntyre	M.	Scottish	1931
A. Macnab	M.	Scottish	1944
T. W. Markland	M.	Lancashire	1919
W. G. H. Millington	M.	Birmingham	1939
A. R. Oldershaw	A.M.	London	1935
W. B. Parker	M.	East Midlands	1905
J. Paul	M.	Scottish	1929
H. S. Pawson	M.	Lancashire	1949
T. D. Richards	A.M.	Wales & Monmouth	1928
W. Ritchie	A.M.	East Midlands	1931
G. E. Roberts, J.P.	M.	General	1919
H. Stringer	M.	Lancashire	1936
A. Sutcliffe	A.M.	Lancashire	1910
W. Swinburn	M.	Sheffield	1935
G. Talte	M.	East Midlands	1928
W. Taylor	M.	Birmingham	1935
Dr. Guido Vanzetti	M.	General	1931
T. H. Warren	M.	Birmingham	1943
O. H. Wass	A.M.	W.R.Y.	1926
R. D. Welford	M.	W.R.Y.	1908
J. E. Wilson	A.M.	W.R.Y.	1928
J. R. Wilson	M.	Scottish	1927
K. W. Winsor	A.M.	General	1950
S. S. Wrightson	M.	Tees-side	1936

Honours

Honorary Membership.—During the past year the Council has conferred honorary membership on five outstanding members of the foundry industry, as follows:—

Mr. Charles W. Bigg of Quarndon, near Derby, past-president and past honorary treasurer of the Institute.

Col. W. J. Grose of Mondeor, near Johannesburg, South Africa.

Dr. James T. MacKenzie of Birmingham, Alabama, U.S.A.

Mr. D. Sharpe of Glasgow, past-president of the Institute.

Mr. O. Smalley, O.B.E., of New York City.

Honours Conferred upon Members.—The Council congratulates the following members who have been honoured during the year:—

G. L. Bailey (member of Council) was awarded a C.B.E. in the New Year's Honours list.

W. Bulloch (member) has been appointed senior magistrate by the Denny and Dunipace Town Council.

Ambrose Firth (member) has been elected president of the Sheffield and District Engineering Trades Employers' Association.

Colin Gresty (president) has been elected a vice-president of the British Cast Iron Research Association.

R. L. Handley (member) has been elected chairman of the Information Committee of the British Cast Iron Research Association.

Dr. J. E. Hurst (past-president) has been re-elected president of the British Cast Iron Research Association.

C. S. Johnson (member) has been awarded the Institution Medal of the Institution of Production Engineers for the best Paper presented by a non-member during the 1949-50 session.

Sir Andrew McCance, D.SC., LL.D., F.R.S. (member) has been elected president of the Institution of Engineers and Shipbuilders in Scotland.

W. C. Meredith (member) was awarded an M.B.E. in the Birthday Honours.

A. E. Peace (member) has been re-elected chairman of the research Board of the British Cast Iron Research Association.

John J. Sheehan (past-president) has been re-elected chairman of the Council of the British Cast Iron Research Association. He has also been elected chairman of the Association's development committee.

W. G. Thornton (past-president of the West Riding of Yorkshire branch) has received a presentation from the members of the West Riding Ironfounders' Association, as a mark of appreciation of his two years' service as president of the Association.

The Secretary.—T. Makemson, M.B.E., secretary of the Institute, completed 25 years' service in this capacity on December 1, 1951. Mr. Makemson has also completed 25 years' service as honorary secretary of the International Committee of Foundry Technical Associations.

Awards

The following awards were presented at the annual general meeting held at Newcastle-upon-Tyne in June, 1951.

E. J. Fox Medal: To Mr. H. Morrogh, in recognition of his pioneer work on nodular cast iron and of his elegant contributions to research on cast iron over a period of years.

British Foundry Medal: To Mr. E. S. Renshaw, for his joint authorship of the Paper "Some Modifications in Cupola Design," which was published in Volume XLIII of the proceedings of the Institute.

British Foundry Prize: To Mr. S. J. Sargood, for his joint authorship with Mr. Renshaw of the same paper.

Meritorious Services Medal: To Mr. A. S. Worcester, in recognition of his valuable services to the Institute in many capacities over a long period of years.

Diplomas: Diplomas were awarded to the

following members for papers presented at the branches named below:—

J. Currie	Scottish branch.
G. W. Fearfield	East Midlands and Lancashire branches.
M. M. Hallett	London branch.
D. Redfern	Lancashire branch.
Dr. E. Scheuer	Slough section.
K. H. Wright	Birmingham branch.

Edward Williams Lecture

The Edward Williams Lecture for 1951 was delivered at the annual general meeting at Newcastle-upon-Tyne on June 13, 1951, by R. W. Bailey, D.SC., F.R.S., the title being "The Properties of Materials and the Engineering Uses of Cast Metals." The 1952 Edward Williams Lecture will be delivered at the Buxton and Sheffield Conference by Professor R. J. Sarjant, O.B.E., D.SC. The title of the lecture is "Fuel and Metal."

Branch Activities

Reports from the branches confirm that the past year has been one of maximum activity, every branch and section having provided a full programme of lectures, works visits and, in most cases, social functions, which have been enthusiastically supported by the members. The Council is pleased to report that the inauguration of the North Eastern section of the Scottish branch has been conspicuously successful and that the efforts of the Lancashire branch to enlist the interest of foundrymen in outlying regions of the branch area have been continued by the holding of meetings at St. Helens, an example which has been emulated by the Sheffield and District branch, which has held a series of meetings in the Doncaster area, and by the London branch which has been endeavouring to stimulate interest in Southampton.

The Council again wishes to express its special thanks to the branch presidents, branch secretaries, and other branch officials whose spirited exertions have inspired the continued vigour with which branch affairs are conducted and on which the well-being of the Institute as a whole fundamentally depends.

Middlesbrough branch.—On the recommendation of the Middlesbrough branch the Council of the Institute at its meeting in January agreed that in future this branch shall be known as the Tees-side branch. Since its formation twenty-five years ago the branch has grown considerably in numbers and its members are now spread over a large area. The new title is much more representative of the geographical area covered by its members.

National Works Visits Day

Intended to supplement the arrangements made by the branches and at annual conferences, the annual National Works Visits Day provides an opportunity to take part in an annual national gathering for those members who cannot spare the time to attend the whole of an annual conference. Organized by the London branch the second of these annual events was held on October 12, some 278 members participating in visits to eight groups of foundries in the London area. At the conclusion of the day's events a warm tribute was paid to Mr. W. G. Mochrie, the London branch secretary, for his excellent organization of the arrangements and to Mr. R. B. Templeton (past-president) who inspired what has proved to be a very popular enlargement of the Institute's activities.

Technical Development and Education

Reference has been made in previous annual reports to the inestimable advantages which have been derived by members and the industry as a whole from the extension of the Institute's work in the field of technical development and education, which has been made possible by the grant by the Joint Iron Council for these purposes. The grant for the period under review has been applied to a number of valuable projects, including a further foundry foremen's training course, the provision of assistance to enable a selected student to take a course at the National Foundry College, the publication of a number of special reports and several developments in the work of the Technical Council, one of which, a highly-instructive film on the flow of metal into moulds, which has been prepared by sub-committee T.S.35, will be presented at the annual conference in June.

Educational Activities

That the new and revised edition of the specimen notes for teachers, entitled "Lectures in Foundry Practice," based on the Foundry Practice Intermediate examination syllabus of the City and Guilds of London Institute has met an urgent need is evidenced by the keen and sustained demand for copies of this publication which has been received from educationalists during the past year. Progress in the work on the corresponding lecture notes for the final examination has been delayed due to the overwhelming pressure of other Institute work, but it is hoped that it will be possible to complete this publication during the next twelve months.

The Institute's part in the formation of the City and Guilds of London Institute examinations in foundry practice and patternmaking and the value of these examinations to the foundry industry were referred to at some length in the January issue of the Institute's *Journal*. The Institute has continued to advise on the management of these examinations during 1951, and the results which are recorded below indicate that the examinations continue to meet the needs of an ever-increasing number of students:—

Patternmaking—Intermediate

Number of candidates.	Pass 1st Class.	Pass 2nd Class.
292	53	136
Patternmaking—Final.		
131	16	51
Foundry Practice—Intermediate.		
207	29	88
Foundry Practice—Final.		
106	17	43

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The following prizes offered on behalf of the Institute were awarded to successful candidates:—

Foundry Practice: Final Grade: Buchanan Medal to F. G. Horton, Wolverhampton; Buchanan Prize to D. Lewis, Wednesbury.

Patternmaking: Final Grade: Buchanan Prizes to E. S. G. Gargan, Glasgow, and K. Scott, Rochdale.

Foundry Practice: Intermediate Grade: P. H. Wilson Prizes to R. W. G. Layton, Gateshead (first prize) and R. Lockwood, Sheffield (second prize).

Patternmaking: Intermediate Grade: P. H. Wilson Prizes to J. F. Haywood, Coventry (first prize) and R. D. Smith, Letchworth (second prize).

Publications

Preprints of Papers presented at the Newcastle Conference were made available without charge to all members on request. In addition, the following publications have been issued during the past 12 months:—

Volume XLIV of *Proceedings*; *Journal* of the Institute, which has been published at two-monthly intervals; final report of sub-committee T.S.20 on "*Evaluation of Soundness in Cast Iron*"; final report of sub-committee T.S.30 on "*Synthetic-resin Corebinders*," and final report of sub-committee T.S.31 on "*The Heat-treatment of Grey Cast Iron.*"

Foundry Foremen's Training Course

The success of the fourth Foundry Foremen's Training Course, held at Ashorne Hill, Leamington Spa, from April 3 to 5, 1952, matched that of the three previous courses held at this venue. A total number of 235 visitors attended the course and a number of applicants could not be accepted owing to the restricted sleeping accommodation. The Council wishes to record its indebtedness to the many past-presidents who, in support of the president and vice-presidents, attended and rendered invaluable assistance in ensuring the success of the course.

Students' Grants

On the recommendation of the assessors, Mr. L. W. Bolton, Dr. A. B. Everest, Mr. A. S. Worcester and Mr. G. L. Harbach, the student's grant for 1951 was awarded to Mr. Gordon Foster, an employee of J. Blakeborough & Sons, Limited, and an associate member of the Institute, who elected to use the grant to enable him to take a course at the National Foundry College, Wolverhampton, where he commenced his studies in September. The Council is pleased to announce that Mr. R. K. Jackson, who received the 1950 grant, was awarded a scholarship, which has enabled him to spend a further year at the National Foundry College. As already announced, the Council proposes to offer a further grant for award in 1952.

International Contacts

A party of approximately 50 members of the Institute, including the president (Mr. Colin Gresty), Mr. Noel P. Newman, Mr. P. H. Wilson and Mr. V. C. Faulkner (past-presidents) visited Belgium in September to take part in the International Foundry Congress at Brussels. Arrangements were completed for an organized party to participate in the International Foundry Congress to be held in Atlantic City from May 1 to 7, and to take part in the pre- and post-Congress study tours of U.S.A. foundries. These arrangements had, however, to be carried out on a more modest scale than originally intended by reason of currency restrictions.

These visits do much to cement the already cordial friendships which exist between the Institute, the American Foundrymen's Society and the Continental associations, with several of which organizations an exchange of Papers has again been effected.

The executive committee, on behalf of the Council, was honoured to welcome and entertain Mr. W. O. Adams, vice-president of the Institute of Australian Foundrymen Victorian Division, and Mrs. Adams, who spent several months in this country and Europe in the latter part of 1951. Mr. Adams, who met many members of the Institute during his sojourn in this country, will be well known to many as the chairman of the committee responsible for sending the food parcels from Australia to members of the Institute.

Relations with Other Organizations

The Institute has co-operated during the past year with a large number of outside organizations, including the Joint Committee on Metallurgical Education, the committees administering the Mond Nickel Fellowship and many technical committees of the British Standards Institution. As will be noted from the report of the Technical Council, which is printed separately, co-operation on technical matters has also been fostered with the British Cast Iron Research Association, the British Steel Founders' Association, the British Non-Ferrous Metals Research Association, the Light Metal Founders' Association, and the Association of Bronze and Brass Founders.

Annual Golf Meeting

The Institute's Golfing Society held its sixth annual golf meeting at Woodhall Spa on Saturday and Sunday, September 29 and 30. Of the record attendance of 64 members and ladies, 38 took part as competitors in the various events. The arrangements were made by Mr. F. Arnold Wilson, honorary secretary of the Golfing Society. Mr. R. B. Templeton (past-president) was re-elected president of the society for the ensuing year.

Council and Committees

The Council of the Institute has held its usual quarterly meetings during the past twelve months. In addition, four meetings of the Technical Council, five meetings of the executive committee and numerous meetings of the standing committees have been held. The increased number of technical sub-committees in being has resulted in a corresponding increase in the number of sub-committee meetings which in the past twelve months have attained a record.

(*continued on page* 632, *col.* 2)

Birthday Honours

Awards to many people associated with the coal, iron and steel, and allied industries are contained in the Birthday Honours List, which was published last Thursday. Brief notes on some of the principal awards are given below.

BARONETS

SIR (GEORGE) LEIGHTON SEAGER, for political and public services. In business, Sir Leighton is associated principally with dock and shipping companies. He is vice-chairman of the Barry Graving Dock & Engineering Company, Limited, Mountstuart Dry Docks, Limited, and Cardiff Channel Dry Docks & Pontoon Company, Limited, and deputy chairman of the Bute Shipbuilding, Engineering & Dry Dock Company, Limited, and Tredegar Dry Dock & Wharf Company, Limited.

MR. GEOFFREY SUMMERS, for political and public services in Wales. Mr. Summers, who is a director of John Summers & Sons, Limited, joined the firm in 1912, becoming a director in 1921. He is also a director of the Shelton Iron, Steel & Coal Company, Limited, the Castle Firebrick Company, Limited, the Coking Company, Limited, and the Export Agency Company, Limited.

KNIGHTS BACHELOR

MR. BERNHARD HEYMANN BINDER, who is a chartered accountant, is also chairman of the Central Wagon Company, Limited, and other companies, while his directorships include the British Tyre & Rubber Company, Limited, India Rubber, Gutta Percha & Telegraph Works Company, Limited, and International Combustion (Holdings), Limited. MR. WILLIAM SCOTT FARREN, technical director of A. V. Roe & Company, Limited, the aircraft manufacturers. He is also a director of the Security Anchor Company. MR. JOHN HENRY KEELING, deputy chairman of British European Airways Corporation. His many directorships include membership of the boards of Fairbairn Lawson Combe Barbour, Limited, founders and textile machinery makers, of Leeds, and Urquhart Lindsay & Robertson Orchar, Limited, textile engineers and founders, of Dundee. MR. LESLIE ROBERTS, chairman and managing director of the Manchester Ship Canal Company. MR. HERBERT BABINGTON ROBIN ROWELL, chairman and managing director of R. & W. Hawthorn Leslie & Company, Limited, shipbuilders, boilermakers, etc., of Newcastle-upon-Tyne. MR. GEOFFREY HERBERT SAVAGE, chairman of the Central Conference of Employers and Trade Unions in the Engineering Industry. He is works director of the Rover Company, Limited.

ORDER OF THE BATH

Civil Division

K.C.B.

MR. EDWIN ALAN HITCHMAN, Permanent Secretary, Ministry of Materials.

C.B.

MR. IAN MCMILLAN FORSYTH, under-secretary, Ministry of Fuel and Power; MR. HERBERT GEORGE LINSDELL, under-secretary, Ministry of Supply; MR. JOHN WEDLAKE, Director of Armament Supply, Admiralty.

ORDER OF ST. MICHAEL AND ST. GEORGE

G.C.M.G.

EDWARD GEORGE WILLIAM TYRWHITT, VISCOUNT KNOLLYS, for services as the representative of H.M. Government on the International Materials Conference.

K.C.M.G.

SIR CECIL MCALPINE WEIR, for services as a member of the Dollar Exports Council. He is chairman of the British Tabulating Machine Company, Limited, and holds other directorships, including that of the Pyrene Company, Limited.

C.M.G.

MR. JOHN HERBERT BROOK, assistant secretary, Ministry of Fuel and Power.

ORDER OF THE BRITISH EMPIRE

Civil Division

C.B.E.

GEORGE BARRIE, chairman of Barclay, Curle & Company, Limited, shipbuilders, etc., of Glasgow; EDWARD CYRIL BOWYER, director of the Society of British Aircraft Constructors; SIDNEY ALFRED DAVIS, regional controller, Midland Region, Ministry of Supply; MAJOR GILBERT DENNISON, chairman of the Export Committee, British Jewellers' Association, who is also chairman of Associated International Presswork, Limited, Associated Chain Company, Limited, and a director of Birmingham Tool & Gauge Company, Limited, and other companies; GEORGE ROBERT EDWARDS, chief designer, Vickers-Armstrongs, Limited, Weybridge; ROBERT PORTER CORRY GOTTO, a member of the council of Belfast Chamber of Commerce and a member of Belfast Harbour Commissioners, and a director of the Belfast Ropework Company, Limited.

(*To be continued*)

I.B.F. Annual Report

(*continued from previous page*)

Of the members of the Council elected by ballot for two-year periods, five retire each year by rotation. Those who so retire at the annual general meeting in 1952 are:—Dr. A. B. Everest, Mr. Barrington Hooper, C.B.E., Mr. R. L. Handley, Mr. A. E. Peace and Mr. R. Shepherd.

The Council's hearty and sincere thanks are tendered to the many members who have actively participated in the work of the Institute during the past year and in particular to Mr. A. E. Peace and Dr. A. B. Everest, respectively chairman and vice-chairman of the Technical Council, and to Mr. Noel P. Newman, J.P., honorary treasurer, for the onerous duties they have shouldered with such marked success.

At the annual general meeting to be held at Buxton on June 11, the Council will nominate the following officers for the year 1952/53:—

As *president:* Dr. C. J. Dadswell.

As *senior vice-president:* Mr. E. Longden, M.I.MECH.E.

As *junior vice-president:* Mr. John Bell.

1951 Annual Conference

The Council takes this opportunity to express special thanks for the work of the conference committee, the conference secretary, the conference treasurer and all others who were responsible for the excellent arrangements of the immensely successful conference held at Newcastle-upon-Tyne in June, 1951.

The 49th annual conference, organized by the Sheffield and District branch, will be held at Buxton from June 10 to 13, 1952, inclusive.

The report is signed by MR. COLIN GRESTY, *president*, and MR. T. MAKEMSON, *secretary*.

Cold-cathode Lighting

Cold-cathode lighting has been installed in the foundry of K. & L. Steelfounders & Engineers, Limited, where locomotive-wheel centres, traction motor castings and track-links for tanks, excavators and cranes are among the products. Originally adopted as an experimental replacement for tungsten-filament illumination, the new system is now being extended to the remainder of the foundry, and has also been installed in a steel store. The General Electric Company, Limited, supplied for this installation three-light, 9-ft. model F.9005 cold-cathode fittings, with two modifications designed to suit the possibility of dust-laden and corrosive atmospheres—first, the reflectors were vitreous enamelled instead of stove enamelled, and secondly, the tops were closed instead of slotted.

The fittings were mounted above the crane rails at a height of 16 and 24 ft. from ground level, as shown in Fig. 1. From Fig. 2 it is clear that the use of an almost continuous light source has reduced shadows under the crane to an absolute minimum, eliminating the necessity for additional lighting under the crane. The installation, comprising 66 fittings arranged in two rows with a 25-ft. spacing between rows, is planned for an average illumination throughout the life of 8 lumens per sq. ft. at floor level.

FIG. 1. (*left*)—*Cold-cathode Fluorescent Lighting at the Foundry of K. & L. Steelfounders & Engineers, Limited.*

FIG. 2.—*Reduction of Shadows under the Crane to a Minimum has Eliminated the Necessity for Additional Lighting under the Crane.*

Dearth of Scrap Metal in South Wales

At the moment South Wales had only a week's supply of scrap metal, Mr. A. S. Davies, of the East Wales Scrap Drive Committee, told Monmouthshire county executive committee of the National Farmers' Union at Abergavenny recently. Emphasizing the great importance of scrap metal to the rearmament programme, Mr. Davies asked the committee to consider putting farm scrap, of which there was estimated to be more than 200,000 tons on farms in the county, at the disposal of the steel industry.

The prices offered of £4 10s. per ton if delivered by the farmer to one of the scrap dumps which would be set up, and £3 if collected at the farm, were considered too low by some members of the committee. It was decided, however, to have the necessary arrangements made for the introduction of the scheme, subject to review in six months' time.

THE INSTITUTION OF PRODUCTION ENGINEERS announce that the Eastern Counties section will visit Suffolk Iron Foundry (1920), Limited, Stowmarket, on June 25, beginning at 2.30 p.m.

Foundrymen to ask for Wage Increase

It was unanimously decided at the annual conference of the Amalgamated Union of Foundryworkers at Blackpool last week to apply through the Confederation of Shipbuilding and Engineering Unions and the joint committee of Light Metal Trades Unions for a substantial increase in wages. The conference rejected an amendment fixing the amount of the application at £2 a week by 47 votes to 13.

In presenting its resolution the executive council proposed that a definite figure should be decided on the eve of a meeting with the employers, fixed for June 25 or 26, on the basis of information then available, relating to the cost of living and wage rates. The claim was to be made immediately, and the increase should be retrospective to the date of application.

MR. DUNCAN SANDYS, Minister of Supply, paid a visit to Rolls-Royce Limited, Nightingale Road, Derby, on June 3. He was met at the works by Lord Hives, chairman and joint managing director, and Mr. J. D. Pearson, a director, and general manager of the Aero Division of the Company.

Quality of Investment Castings as Influenced by Gating and Mould Turbulence*

By Rawson L. Wood and Davidlee Von Ludwig

Mould temperature does not affect hardenability or tensile strength of the various ferrous alloys studied at Arwood Precision Casting Company in relation to investment casting practice. Gating designed for minimum turbulence in the mould cavity produces the cleanest castings and the least scrap.

Uniformity of dimensions and rigid physical property specifications require very exact foundry technology for investment casting production. Analysis of the factors affecting commercial alloys used in investment casting have been undertaken at the Arwood Precision Casting Company, Brooklyn, N.Y., the purpose being to determine physical-property curves for commonly used ferrous and non-ferrous alloys as secured by normal investment foundry processing.

The variables being investigated are:—(1) Pouring temperature and its effect on grain size, ductility; (2) investment and flask temperature effects on grain-size and physical properties; (3) effect of turbulence as controlled by gating technique; (4) effects of standard heat-treatment techniques in developing desired physical properties, and (5) effects of environmental variations on final physical properties of various commercial alloys as investment castings. Other properties studied, but not reported here were:—(6) Effect of bake-out and burn-out techniques on the physical properties of metals cast into partially- and totally-burned-out moulds, and (7) effects of permissible deviations in alloy chemistry within the breadth of normal specifications.

Alloys Studied

The first studies were made on outstanding common alloys representing basic steel families. Included were: stainless 410 (B.S. 2 S61—C, 0.15; Ni, <1.0, and Cr, 12/14 per cent.), a martensitic, heat-treatable high-chromium steel; S.A.E 4140 (EN 19—Mo, 0.25 to 0.4; C, 0.35 to 0.45; Mn, 0.5 to 0.8, and Cr, 0.9 to 1.5 per cent.), a low-alloy, medium-carbon structural steel, and 52100, a high-carbon, low-alloy tool-steel. Studies of other alloys, such as 4130 (much the same as 4140), 303, and 304 (18:8 Cr/Ni) stainless and 440C martensitic stainless, while not complete, tend to support conclusions reported here.

Over 20 partial and complete heats of these three alloys were made using electric induction melting crucibles and poured into lots of about 48 test-coupons per heat, for a total of over 2,000 test specimens. The 150-lb. melts permitted close control of alloy additions. Specimens mechanically unsound, due to inclusions, cracks or other defects were eliminated from the results.

In small sections, the castability of alloys is different. Alloy selection has been based on factors such as surface smoothness, apparent fluidity, as indicated by reproduction of fine detail, and other factors relating to the rate of production. Such recommendations usually failed to define the causes for variable deficiencies, and have been useful only as approximate guides.

Surface Condition

Where surface smoothness has been emphasized unduly, recommendations have been made repeatedly against martensitic stainless alloys such as types 410 and 416. In the investment-cast form, there is no real difference between these two grades. Of all

* Reprinted by courtesy of *Iron Age*. The Authors are, respectively, managing director, Arwood Precision Casting Company, Brooklyn, New York, and consultant, Brooklyn, New York.

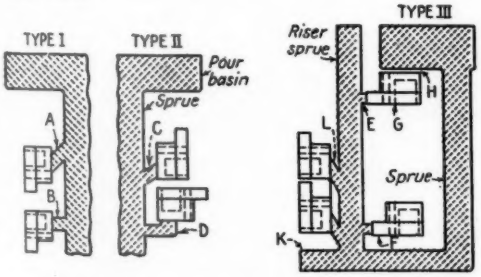

FIG. 1.—*Typical Grating Set-ups, modified to permit Quiet Bottom Filling, and Minimum Mould Turbulence, aid in producing Satisfactory Investment Castings. Designs which require Multiple Gating place a premium on the use of Insensitive Alloys.*

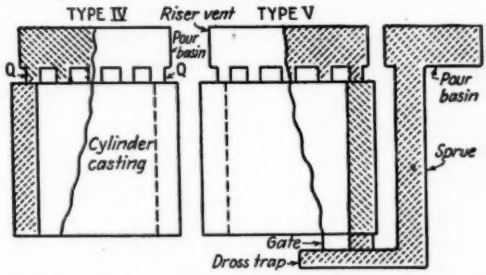

FIG. 2.—*Small, Numerous Gates used for Larger Castings (Type IV) restrain larger Dirt and Dross but do not minimize the Formation of Oxides, Nitrides and other Drosses as does the arrangement shown in drawing (Type V). The Cylinder Form was used for illustration only.*

Quality of Investment Castings

alloys tested, 410 stainless is most uniform in its response to investment casting and subsequent heat-treatment. The high-chromium steels, martensitic and austenitic, because of inherent chemical stability, result in decreased formation of oxides or an increase in their solubility.

It has been standard for the investment industry to recommend stainless type-302 or -304 for replacement of nearly all ferrous alloys where high hardness is not essential. The studies indicate that the 410 stainless alloy should be applied where moderate hardenability and uniform impact resistance are required.

Grain-size in ferrous and non-ferrous castings has been arbitrarily presumed to be a weak factor in investment castings. While alloys which tend to have coarse grain as otherwise cast, do have relatively coarse structure in the investment-cast form, the present study has shown that coarsening of grain and basic physical properties are not materially affected by flask temperature.

Mould Temperature

No noticeable effect on hardenability or tensile strength of the 4140 alloy can be traced to flask temperature prior to pouring. The increase in hardness when the alloy is tempered at 1,450 deg. F. (785 deg. C.) and air-cooled is due to re-hardening. Furnace cooling to 1,400 deg. F. (760 deg. C.) from a drawing temperature of 1,525 deg. F. (829 deg. C.) lowered the hardness again. The resulting tensile properties were substantially higher than those obtained by direct tempering at 1,400 deg. F. (760 deg. C.) from those quenched in oil from the 1,550 deg. F. (890 deg. C.) condition, the basic treatment for all 4140 and 4130 alloy test-bars. Specimens for the above data were cast from four separate heats of 150 lb. each. Over 200 bars were made and broken for this specific test in 4140 alloy alone.

Effect of Turbulence

Irrespective of inherent fineness, mechanical and physical properties are largely governed by the type and distribution of non-metallic inclusions. Although type-410 stainless is inherently coarse-grained, 52100 fine-grained and 4140 moderately fine-grained, type 410 is most reliable, due to substantial insensitiveness

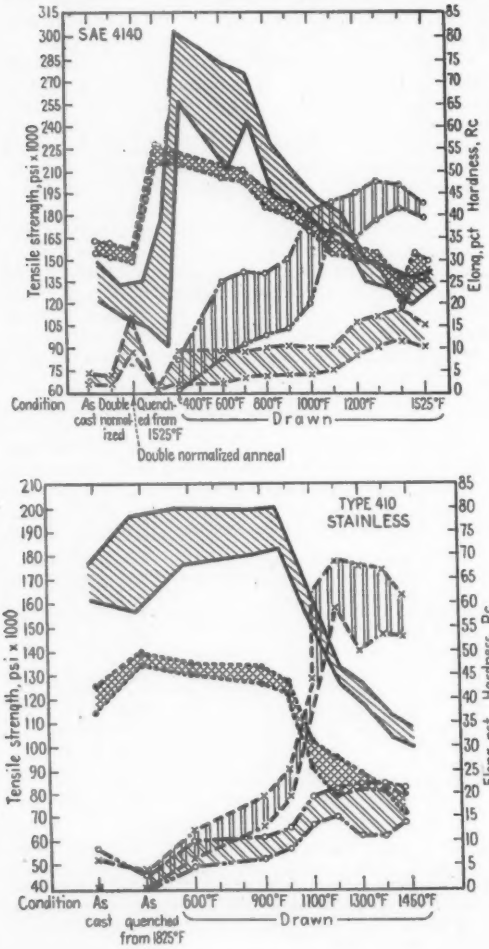

FIG. 3.—*Data collected on Typical Ferrous Alloys (S.A.E. 4140; type 410 Stainless; and S.A.E. 52100) used in Investment Casting. Maximum Potential for any Level of Hardness relates to S.A.E. 4140 with type 410 Stainless Steel a close second.*

Ultimate Tensile Strength — *Hardness Rockwell C.*

Reduction of Area, per cent. — *Elongation, per cent.*

to turbulence and resulting freedom from mechanical defects.

The grain size as-cast of 4130, 4140, and 52100 alloys was affected by turbulence. A higher proportion of bars, as-cast, broke with shear, coarse-grain fractures with almost no measurable elongation. After quenching and tempering, however, fracture characteristics, apparent grain-size and metallographic structures were all substantially identical.

Embrittlement induced by any moderate intensification of grain-growth arising from the influence of mould temperature was so minor as to be of no real significance in considering the use of an alloy for investment casting. Of the metals tested, type 410 was apparently most affected in this respect.

Specimens of 410 alloy cast in flasks at room temperature, when contrasted with specimens poured in flasks pre-heated to 1,400 to 1,800 deg. F. (760 to 980 deg. C.), were visibly finer and less brittle when broken in the as-cast condition. This difference was totally obliterated by proper heat-treatment. When test-samples were oil-quenched from 1,825 to 1,850 deg. F. (995 to 1,010 deg. C.), then tempered at temperatures from 600 to 1,400 deg. F. (310 to 760 deg. C.), no difference in properties traceable to mould temperature remained.

As the 410 alloy is never used in the as-cast condition (stainless properties are developed only in the heat-treated condition), variation in as-cast properties is inconsequential. As-cast hardness was not affected by mould temperature in any hardenable alloy. Further, heat-treatable alloys have a semi-quenched structure which in some instances approaches maximum hardenability of the alloy.

Heat Transfer

It is generally believed that "slow" cooling of the metal in an investment flask would cause very coarse grain, and tend to produce fully annealed castings. This belief is based upon a misconception of the relative heat transfer and suppression of cooling through the critical range of the metal.

Semi-quenched parts of fine grain-size result from the wide difference between flask temperature (1,800 deg. F. (980 deg. C.)) and metal (above 3,000 deg. F. (1,650 deg. C.)). Also, grain-size in an investment casting weighing a pound or less, is radically finer than in most sand-cast masses. The influence of solidification quenching in investment moulds was evident in studies made on ingots of 3120 alloy steel. Surface hardnesses of 35 to 40 Rc often prevented bandsaw sectioning of ingots until annealed. With 0.20 per cent. C, the alloy was not normally considered hardenable except by carburizing or similar additive processing.

Gating Practice

Tests of type-410 stainless alloy emphasized the importance of proper gating and venting in production of reliable structural parts of alloys such as 4130 or 4140. Irrespective of the type of gating, more than 90 per cent. of the 410 specimens were mechanically sound. In cases of maximum turbulence induced by poor gate-design, test specimens of 4140 would often be 90 per cent. defective.

It was demonstrated the 4140 alloy could be made equally as reliable as 410 stainless, by using single-point gating and inducing flow away from the gate through adequate end-vents. Several heats of 4130 and 4140 had yields in excess of 90 per cent. sound bars for tests.

Gating set-ups typified by Type I, Fig. 1, are most common for the production of small castings in a single flask. Direct admission of metal by the shortest path, intended to assure maximum fill of fine details, is metallurgically unsound for sensitive alloys. Suited to stable metals such as 410 stainless or 18-8 stainless, it is not suited for clean castings of alloys 4140, 52100, etc. Gate A or B may easily be changed by inversion as shown in gating Type II, at C and D.

Small Gates Ineffective

Gate E, in set-up Type III, is held to minimum length consistent with easy cut-off and may be used if the projection shown at F is adequate to fill the balance of the casting. If not, gating should be as shown in C, D or L. The location of the top casting in a set-up, as shown by G must permit adequate clearance at H. Hydrostatic head must be sufficient to ensure complete filling. Type-III gating yields the highest cleanliness in castings, but is costly. K is a projection on the runner to trap dross or dirt on the entering metal-stream face.

Where single castings are set-up in individual flasks, Type-IV gating, Fig. 2, frequently is used. Small, numerous gates, Q, minimize shrinkage and are easy to cut off. They restrain the entrance of larger dross or dirt particles. They do not prevent formation of oxides, nitrides or other drosses resulting from splatter and turbulence within the mould cavity.

Harmful Oxide Films

Quiet bottom-feeding, possible with Type-III gating, may also be obtained with Type V gating. The separate pouring-basin, down-sprue and bottom contoured single-gate arrangement is more costly, but minimizes non-metallic inclusions. The pouring-basin-gate set-up of Type IV becomes the vent/riser in Type V. A fundamental rule for gating sensitive alloy parts subject to the effects of turbulence must be to admit the metal at the lowest point in the casting cavity, with minimum velocity, and from a single gate.

No real merit has been found in trying to correlate X-ray inspection as a means of controlling the flow pattern because of the impossibility of seeing grain-boundary oxide-films. The thickness of most oxide films was such that, regardless of orientation with respect to the X-ray beam, they were invisible in the radiographic negative. These oxide-films have proved to be most detrimental to the physical properties of the castings. Metallic oxides formed in pouring 410 stainless alloy are found either on the surface of the solidified metal in the form of surface pits or appear as soluble internal inclusions.

While about 20 per cent. of all the 410 alloy bars tested in the as-cast condition broke prematurely due to the presence of visible defects, less than 5 per

(*Continued on page* 638, *col.* 2.)

Fuel-saving Equipment Loans

Particulars of Fuel and Power Ministry's Scheme

The Ministry of Fuel and Power has set out in an explanatory leaflet the details of the scheme announced by the Minister in the House of Commons last week under which firms may apply for loans at commercial rates of interest to cover expenditure on the installation (including capital cost) of approved fuel-saving equipment and structural insulation.

The scheme is open to industrial firms which wish to instal approved fuel-saving equipment or to insulate their factories in order to save substantial quantities of fuel, but who have not sufficient capital available from their normal sources of finance. The total amount provided by way of loans will not exceed £1,000,000 and loans to individual firms will not normally exceed £25,000. Subject to this limit, the amount of the loan offered in suitable cases may cover the whole cost of the proposed installation, including essential ancillary work.

Types of Installation Covered

Since the capital available for loans is limited, and the scheme is to be in operation as an experiment for one year only, loans will be made available only for work completed within a reasonable time, and, in any case, not later than five years from the commencement of the scheme, on structural insulation of existing factory buildings and the following items of equipment which, when introduced *as part of existing plant*, will automatically save substantial quantities of fuel:—

(*a*) Back pressure engines and turbines introduced as part of space heating or process steam installations to generate power.

(*b*) Feed water economizers installed for pre-heating water by means of hot waste gases.

(*c*) Air pre-heaters installed for pre-heating air for combustion or for process use by means of hot waste gases from boilers or furnaces.

(*d*) Heat exchangers installed for heating gas or liquid essential for process use or for space heating by means of hot waste gases, vapours or liquids the heat in which would otherwise be wasted.

(*e*) Waste heat boilers installed for utilizing heat which would otherwise be wasted.

(*f*) Structural insulation of existing single sheeted factory roofs and walls.

If a loan is granted under this scheme it will still be necessary for the firm concerned to obtain any necessary licences, etc., which may be required before the work can be carried out.

The applicant should complete the application form L.F.S.2, which is obtainable, on written request, from the Ministry of Fuel and Power, Fuel Efficiency Branch, Queen Anne's Chambers, Dean Farrar Street, London, S.W.1. The applicant will be required to give an estimate of total cost of installation; expected change in fuel consumption; time needed to complete the installation; and the cost of building work involved and the amount of building materials required.

A brief specification and general arrangement drawing of the proposed installation should be associated with the application which should be countersigned by a consulting engineer or engineering contractor.

A firm which, before consulting an outside consultant or engineering contractor, would like advice on the types of installation eligible for consideration for loans under the scheme may apply to the regional fuel engineer of the Ministry of Fuel and Power for the region in which the firm is located. He will try to give all the help required, but he will not be in a position to advise the firm concerned whether or not a loan is likely to be granted on application in respect of any particular installation.

Applications will be dealt with in order of the date of receipt. If necessary, a Ministry engineer may visit the premises of the firm concerned to clear outstanding technical points. So far as possible, however, applicants should give sufficiently detailed information in the application form to avoid the need for such visits.

Quality of Investment Castings

(*Continued from previous page*)

cent. were similarly affected after solution or quenching treatment. This tendency was found on test-specimens from five separate melts. It seems reasonable that some modification of the form of retention of non-metallics characterizes martensitic stainless such as 410. This does not apply to either 4130-4140 or 52100-5280 types.

The trade has long emphasized the need for designing parts to permit use of one large gate for the admitting of metal to the cavity. Tests confirm the need for this design practice. Moreover, care is needed in selecting an alloy for a "difficult" design. Where dynamic loadings will be encountered, all design factors relating to turbulence should be considered.

Oxides on the Surface

Oxides which form on the liquid surface of low-alloy steels, such as 4140 or 52100, tend to be trapped within the solidified structure. They constitute planes or points of weakness. Where the same melting and pouring practice was employed, using the standard 3-point test-bar gating most inductive of turbulence, 90 per cent. of low-alloy steel specimens failed due to inclusions.

Correct location of the casting cavity in the flask, and use of gating and venting which allow quiet bottom-filling will permit as high yields of clean parts in sensitive alloys such as 4140 as may be secured as in insensitive alloys gated at random.

The properties of heat-treated, clean 4140 steel are substantially superior, with respect to maximum tensile strength, to other investment-cast alloys tested. It is one of the most shock-resistant investment casting structural alloys when adequately designed and gated. S.A.E. 4140 and all low-alloy or straight carbon steels are somewhat sensitive to formation of insoluble inclusions when so poured that turbulence is excessive. Test data are shown in Fig. 3.

Studies of 52100 vanadium-modified tool-steel re-emphasized the importance of freedom from minute insoluble inclusions and the influence of inclusions on all dynamic properties. S.A.E. 52100 in the investment foundry is specified not only for tool and other high-hardness applications, but also for moderately-loaded structural applications. Use of the 52100 alloy for impact-loaded designs, however, should be eliminated. It is among the most fluid of all ferrous alloys.

Personal

MR. ERNEST LEWIS has been appointed secretary of Matthew Swain, Limited, ironfounders of Manchester, in succession to Mr. R. Crawshaw, who, however, will remain as managing director.

MR. RALPH P. JONES, chairman of John Jones, Limited, Britannia Foundry, Loughborough, has recently re-visited Spain, where he once lived for 17 years, and gave a party for people he used to employ there.

MR. PETER SPEAR has been appointed director of research and development of Rubery Owen & Company, Limited, structural and manufacturing engineers, of Darlaston (Staffs). MR. W. HOLMES has been appointed chief buyer.

MR. JOHN C. BARWICK, president of the Keighley Association of Engineers, has been nominated by the association for the presidency of the West Riding Engineering Federation, which comprises eight engineering associations.

MR. J. SINCLAIR KERR, assistant managing director of the Lancashire Steel Corporation, Limited, recently completed 25 years with the Corporation. Many tributes were paid to his personal, technical, and business qualities when he was the recipient of two presentations.

MR. J. H. WRIGHT has been appointed home sales manager of F. Perkins, Limited, Diesel-engine manufacturers, of Peterborough (Northants). He joined the company as an outside sales representative in 1946 and was put in charge of the general sales branch at the head office two years later.

MR. G. M. FLATHER, Master Cutler, and managing director of W. T. Flather, Limited, steel manufacturers, of Sheffield, together with MR. D. A. PALMER, president of the Sheffield Cutlery Manufacturers' Association, took part in talks with Mr. R. G. Menzies, the Australian Prime Minister, in London.

SIR CECIL WEIR, K.B.E., M.C., D.L., has been elected president of the Institution of Production Engineers for the year 1952-53, in succession to Maj.-General K. C. Appleyard, C.B.E. Mr. Harold Burke, vice-chairman of Council for the past two years, takes office as chairman for 1952-53, in succession to Mr. Walter C. Puckey.

MR. R. T. REDFERN, managing director, presided and was elected president at the first annual meeting of the Bryan Donkin and British Furnaces Sports and Social Club, Chesterfield. Among those present were Mr. P. Hopkinson, managing director, British Furnaces, Mr. J. Connerton and Mr. G. Chambers, directors, Bryan Donkin, and Mr. F. Walker, works engineer.

AMONG BUSINESSMEN VISITORS from Australia at present in this country is MR. A. CARMICHAEL, a prominent foundryman of Sydney. Accompanied by Mrs. Carmichael, he recently visited America, where he participated in the International Foundry Congress and in this country he is attending the Buxton Conference of the Institute of British Foundrymen. Due to arrive in the Himalaya on June 14 is MR. A. L. BACKWELL, also a foundryman, from Geelong, Victoria.

DR. EDWIN GREGORY, director and chief metallurgist of Edgar Allen & Company, Limited, steel manufacturers, engineers, and ironfounders, of Sheffield, sailed for America recently. He will attend the second plenary meeting of the International Organisation for Standardization technical committee at Columbia University, New York City. Dr. Gregory is chairman of several committees of the British Standards Institution. The committee meeting in America will be mainly concerned with the standardization of conditions for the mechanical testing of iron and steel.

MR. THOS. F. PROCTER, secretary to Wm. Cumming & Company, Limited, Glasgow, who recently completed 50 yrs.' service with the company, was entertained at a luncheon party on May 28 by the chairman and directors, with Mrs. Procter and some of the staff attending. After lunch, the chairman, Mr. Chas. T. Tenison, presented Mr. Procter with a gold watch and a cheque, remarking that this was not to be regarded as a payment but rather as a sincere token of their thanks and appreciation of his loyal and devoted service to the company. Mr. Bert Winterton, director at the Chesterfield works, and Mr. H. Phillip, director at the Deepfield works, warmly endorsed the chairman's remarks, adding their appreciation and good wishes. Mr. Proctor, replying, recalled that the beginning of his association with the company was in 1902, which began at Chesterfield. Six years later he was transferred to Albion (now Deepfield), 1910 he was sent to Middlesbrough and in 1914 was recalled to take charge at Chesterfield, remaining there until 1924, when he was transferred to the company's head office.

Obituary

THE DEATH has occurred of MR. H. R. GREAVES, civil engineer, who served his apprenticeship with John Fowler & Company (Leeds), Limited.

MR. GEORGE S. BELLAMY, mechanical and electrical engineer for Scotland of British Railways, has died at the age of 59. He joined the service of the former Midland Railway at Derby in 1910 as an engineering apprentice.

New Design for Bell Weights

A new design for bell weights of ¼ oz. to 14 lb. denominations is to be introduced by the Board of Trade on January 1, 1954. The new design, which has been adopted after consultation, is a simplified type, easy to produce and convenient to handle. From January 1, 1954, the new type will be the only type of bell weight of these denominations which can be verified by Inspectors of Weights and Measures. Until that date, however, weight manufacturers can have their existing stocks verified by inspectors in the usual way. Stocks of bell weights of old design thus verified, and all verified weights already in use by traders, will continue to be valid after January 1, 1954.

These changes are made by the Weights and Measures (Bell Weights: Verification and Stamping) Regulations, 1952.* Production and verification of weights of other permitted shapes (i.e., flat circular weights, bar weights and ring weights) are not affected. The gradual introduction of the new design will ultimately result in all bell weights in use being of a uniform type.

* S.I. 1952, No 1119, price 2d.

Open Day at the works of F. H. Lloyd and Company, Limited, James-Bridge Steel Works, Wednesbury, was arranged last Saturday when many hundreds of wives and friends of the employees, visited the establishment and saw for themselves the making of steel castings for which the firm are renowned. Conducted tours were arranged around the works showing the pattern-shop, mould making, the pouring of castings, and the necessary finishing work after which the visitors were entertained to refreshments in the works canteen.

News in Brief

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, has received an order from J. & C. Harrison, London, for two motor cargo ships of 11,000 tons d.w.

JUNE has been selected by the Wolverhampton and Stourbridge group of the National Farmers' Union for an iron and steel scrap drive. Collecting centres are at Tettenhall, Wombourn and Penkridge stations.

SOME 2,000 MACHINES will be on view at an international machine tool exhibition, organized by the Machine Tool Trades Association, which will be held at Olympia from September 17 to October 4.

THE VALUE OF SALES by the Automatic Telephone & Electric Company, Limited, Liverpool, in 1951, was a record in the Company's history, states Sir Alexander Roger, chairman, in his review with the accounts.

IN AN ARTICLE entitled "Increasing Pig-iron Production," in our issue dated June 5, it was stated that the new furnace of the Cargo Fleet Iron Company, Limited, took 7½ years to build. This should have read 2½ years.

BRITISH FOUNDRY UNITS, LIMITED, of Chesterfield, announce that during their annual holidays the works will be closed from July 25 until August 6, during which period no goods will be either received or despatched.

SHOTTS AND DISTRICT TRADES COUNCIL are to seek permission from the Scottish T.U.C. to convene an early conference to discuss the current raw materials shortage and the effect it has had on employment in Lanarkshire.

TWENTY-NINE COUNTRIES are exhibiting more than 2,000 products at Canada's fifth and largest international trade fair, which opened in Toronto last week. The United States and Great Britain are the largest exhibitors, and customers from 60 countries are attending the exhibition.

A FIRE which occurred recently in the die-casting foundry of Hoover (Electric Motors), Limited, Cambuslang (Lanark), was caused by a burst oil pipe on a die-casting machine. The damage, mainly to the building, is estimated at about £2,500, but production is not expected to be affected.

PRODUCTION of aero engine parts came to a complete standstill at the new Rolls-Royce factory at Larkhall on June 3 because of a lightning strike of about 400 workers. The dispute was over a newly appointed shop steward. Larkhall factory came into operation only a year ago with the aim of easing congestion at Hillington and other areas for the production of jet engines.

ENGINEERING WORKERS have been instructed by the South London district committee of the Amalgamated Engineering Union not to tolerate overtime working in firms where redundancy is likely to occur. The committee has also called on its shop stewards to organize factory meetings in support of a demand for a substantial increase in all rates of pay and to press for full employment.

THE Magnesium Advisory Committee has appointed Wenham Brothers & Company, of 21, Bennett's Hill, Birmingham, 2 (Tel. No.: Midland 0994/7), as its permanent secretaries. This Company also has an office in London at 15, Tooks Court, E.C.4 (Tel. No.: Chancery 7161), but communications should normally be addressed to Mr. A. M. M. Burdon-Cooper at the Birmingham office.

THE ORDER-BOOK of Worthington-Simpson, Limited, engineers, of Newark (Notts), had reached an all-time record, including heavy demands for power station and marine pumping equipment, says the chairman, Sir Samuel Beale, in his statement with the accounts for the year ended December 31, 1951. Output was higher than in any other previous year, resulting in an expansion of £37,794 to £593,954 in the trading profit.

THIRTY-TWO Gateshead-on-Tyne foundrymen are so keen on their job that they voluntarily worked two days' overtime so that they could make a holiday trip to Wales—to see another factory. The men concerned were employees of Armstrong Whitworth's Close Works, Gateshead, and they went by bus to visit the biggest continuous strip mill in Europe, at Margam, South Wales. The management offered to pay half the expenses.

DESPITE the success of previous scrap metal drives, a substantial amount of material is being produced from hitherto unconsidered sources and from outlying districts. Already 5,000 tons have been made available in the first four months of the present campaign as a result of concentration on farmlands; and a survey of the islands off the Scottish coast has disclosed as much again, in the form of Nissen huts, landing craft hulls, and ammunition dumps.

THE MAY MEETING of the Victorian Division of the Institute of Australian Foundrymen took the form of a Round Table Conference, the subject of which was Foundry Technique "Methods of Moulding." The speakers were:—Mr. W. O. Adams, of W. O. & B. Adams Brass Founders (Non-ferrous Moulding); Mr. C. Mann, of Vickers Ruwolt Pty., Limited (Ferrous Moulding); and Mr. R. Day, of McKay Massey Harris Pty., Limited (Mechanized Moulding).

MR. A. H. E. MOLSON, Parliamentary Secretary to the Ministry of Works, told Mr. J. Griffiths that the investigations being conducted by the Pneumoconiosis Research Unit were mainly of a long-term nature, but reports were published in the scientific Press as results became available. Studies of the disturbances of lung function due to the disease and of their treatment would be reported soon. He added that Dr. John Gibson, the present assistant director to the unit, had been appointed to succeed Dr. Fletcher as director from October next.

ONLY TWO MATERIAL SHORTAGES remain outstanding—steel and copper—said Mr. A. B. Waring, managing director of Joseph Lucas Limited, when he was installed as president of the Birmingham Chamber of Commerce on May 26. In the case of steel, he said, expanding world production holds out prospect of increased supplies within a reasonable period. Mr. Waring, who succeeds Sir Arthur Smout as president of the Birmingham Chamber, is a past-president of the Birmingham and District Engineering and Allied Employers Association and a member of the councils of the Society of Motor Manufacturers and Traders and of the Federation of British Industries.

MEMBERS of the Mechanical Engineering Research Board, led by Sir Andrew McCance (of Colvilles, Limited), chairman of the Board, and Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, visited East Kilbride last week to inspect the new temporary laboratories of the Mechanical Engineering Research Board at Birniehill. This scheme, of which three buildings have been completed, will, when finished, cost £1,500,000, and will provide research facilities for Government Departments and general industry. Over 200 scientists and technicians are now employed in the laboratories and the total will be increased to 700 in the next two or three years.

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Raw Material Markets

Iron and Steel

The demand for castings and the supply of raw materials remains unchanged. Most foundries have plenty of work on hand, although some of the light foundries report a slight recession in the amount of work available, probably due to the decrease in export business owing to the temporary closing of some oversea markets. Those catering for the engineering, motor, and allied trades are demanding much larger tonnages of pig-iron than they can acquire. Present deliveries of both pig-iron and scrap keep plants operating below capacity. Further, the stock position causes concern, pig-iron, scrap, and coke being at a low ebb. Engineering foundries are short of hematite pig-iron, as one source of supply on the north-east coast has dried up, and deliveries from other furnaces are very short of requirements. There are many inquiries for Continental pig-iron, but few are booking supplies on account of the price.

The light and jobbing foundries have sufficient orders on hand to utilize all the high phosphoric pig-iron they can acquire, and many units are clamouring for increased quantities.

With pressure from both steelmakers and foundries for supplies of pig-iron, producers cannot cope with all demands from present outputs. Scrap remains in short supply, particularly heavy, ordinary and machinery cast-iron scrap. Those foundries using ferro-alloys are able to satisfy their needs.

Foundry coke is coming forward regularly and in sufficient quantities for current consumption, but many foundries are unable to spare any for stocks.

Re-rollers are still anxiously awaiting supplies of semi-manufactured steel to relieve their desperate supply position. Present deliveries make it impossible to programme for production except on a day-to-day basis, and outputs are considerably reduced, although they have good order-books for all light sections, bars, and strip. Home steelworks are sending forward all the supplies of steel semis they can spare, but having some mills out of commission due to shortage of steel, they cannot forward additional quantities. Deliveries from oversea are not yet sufficient to relieve the position appreciably, although there are prospects of improvement shortly. Sheet re-rollers are busy, but in need of larger quantities of sheet bars. All material suitable for conversion is readily accepted, but there are only small arisings of defectives and crops.

Finished iron shows a slight decline and the scrap position remains difficult. The production of forge pig-iron is still well below maximum. Consumers show no signs of relaxing their demands for supplies, although little tonnage is being accepted outside the requirements of the Defence Programme.

There is no improvement in the output of sections and joists. Difficulty is now being experienced in the placing of specifications falling within the super-priority class, as mills already have existing obligations covering their output for some time ahead. Re-rolling mills are still short of suitable billets, etc., although small tonnages are beginning to arrive from oversea. It is hoped that the promised delivery of semis from Japan will be effected shortly. The position remains critical, particularly in regard to bright drawers and wire and strip rollers, who are finding it increasingly difficult to accumulate sufficient raw material to keep one shift per day operating.

Non-ferrous Metals

By comparison with zinc and copper, tin was a steady market last week, although the cash position lost £6 and three months fell by £3. Rather surprisingly, in view of the tendency for stocks to decline, the backwardation narrowed to £5. There was a moderate turnover. Zinc, on the other hand, fell by £28, in two drops of £16 and £12, to £138, the U.S. quotation, which caused this collapse, declining by 3½ cents to 16 cents. This setback in the American price, which had been expected for some time, was touched off by the steelworkers' strike.

In copper, a somewhat remarkable situation developed which can hardly fail to bring about a sharp rise in the price in the U.K., although as we write no announcement has been made by the Ministry of Materials. For many months the f.a.s. New York quotation had been steady at 27½ cents, and on this basis the British Government bought copper from oversea producers. At the end of last week, the figure reported was a range from 32 cents to 36.15 cents., equivalent to £256 to £289.4. It is understood that the American E. & M.J. quotation, on which this quotation is based, had risen as a result of the inclusion of sales by Chile and foreign sales by custom smelters, some of the latter being probably on a toll basis. In spite of some confusion, it can hardly be doubted that a true world price is emerging, and it remains to be seen whether a domestic ceiling of 24½ cents in the U.S.A. can be maintained. Again, it is possible that the British Government may not wish to adopt this revised figure as a basis for purchase, but it is hard to see an alternative. The outlook is obscure, but fluctuations in value are probable.

The usual monthly figures have been published by the British Bureau of Non-ferrous Metal Statistics which cover the month of April. Consumption of copper for the first four months of the year at 204,849 tons was nearly 15,000 tons up on the corresponding period last year. In April it was 49,596 tons, virgin and scrap, a drop of about 2,000 tons on March. At April 30 stocks of virgin copper in the country stood at 107,900 tons compared with 103,520 tons at the end of March. Stocks of lead rose from 110,600 tons to 116,250 tons at April 30, but consumption of all grades declined from 24,695 tons in March to 22,359 tons in April.

Zinc showed a similar trend, the figures being 24,697 tons in March and 22,072 tons in April. Stocks of virgin zinc on hand at the end of April amounted to 64,870 tons compared with 53,390 tons a month earlier. Little change was reported in the tonnage of tin held by consumers, which stood at 1,770 tons at April 30, consumption during that month being 2,021 tons.

London Metal Exchange official tin quotations were as follow:—

Cash—Friday, £970 to £971; Monday, £966 to £967; Tuesday, £970 to £971; Wednesday, £972 to £974.

Three-Months—Friday, £964 to £964 10s.; Monday, £960 to £961; Tuesday, £964 to £964 10s.; Wednesday, £968 10s. to £969.

Copper Sales to U.K. Users Banned

In view of the confused world copper price situation, and pending its clarification, the Ministry of Materials has banned further sales of copper to U.K. consumers for the period beyond the end of June. Sales of copper against consumers' June allocations remain unaffected. Orders for July which were either posted on Friday or submitted by telegrams handed in before 2 p.m. on Saturday will be accepted, but no action will be taken on orders submitted after those times.

The Ministry states that a further announcement will be made before the weekend.